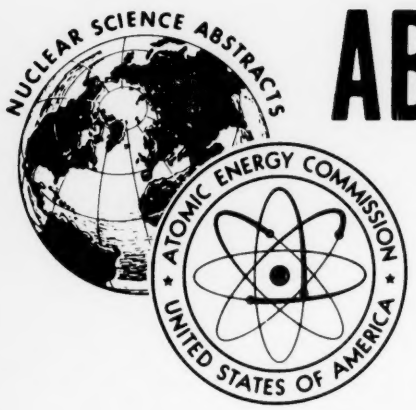
NUCLEAR SCIENCE ABSTRACTS



Volume 27 Number 6

Abstracts 11644-14483

March 31, 1973

UNITED STATES ATOMIC ENERGY COMMISSION

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NOTICE

A title page for Volume 27, Numbers 1–6, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 25, No. 8, Abst. 17478, line one should read: (JINR-E2-4976) E-η MIXING AND SOME RADIATIVE

NSA Vol. 25, No. 9, Abst. 20815, line one should read: (DOCKET-50238-82) N. S. SAVANNAH. Safety

NSA Vol. 25, No. 18, Abst. 42549, should be:

42549 (ORAU-113) 1970 RESEARCH REPORT FOR THE YEAR ENDING DECEMBER 31, 1970. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). 216p. Dep. NTIS.

In 1970 research report for the year ending December 31, 1970. Separate abstracts were prepared on two sections of this report. The third section reports the results of basic studies related to neoplasia and metabolism. A list of 101 publications during the period covered by this report is included. (C.H.)

For abstracts of individual sections see: 42586 and 42587.

NSA Vol. 25, No. 18, Abst. 42587, should be:

42587 (ORAU-113, pp 78-133) RESEARCH IN NUCLEAR MEDICINE. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The effectiveness of radioisotope scanning of ^{67}Ga for the localization of neoplasms in lymphatic tissues was evaluated. The uptake of ^{67}Ga in human tissues obtained at autopsy and in 22 different types of rat, hamster, and mouse tumors was studied. The radiation dose to human spleen, kidneys, adrenal glands, bone marrow, and liver at various times following the administration of tracer doses of ^{67}Ga was measured. The development of computer data analysis and recording systems for the analysis and storage of information on effects of whole-body irradiation on man and for the analysis of data from clinical radioisotope diagnostic tests is discussed. (C.H.)

NSA Vol. 26, No. 13, Abst. 32040, line one should read: (COO-1195-236) STUDY OF THE DIFFERENTIAL

NSA Vol. 26, No. 14, Abst. 34017, line one should read: (NP-tr-1942) ELECTRODYNAMIC INTERACTION OF

NSA Vol. 26, No. 14, Abst. 35653, line one should read: (ORNL-tr-2581) NOISE/SIGNAL RATIO AT SMALL

NSA Vol. 26, No. 15, Abst. 37448, line eight should read: tions for 13 proton groups from the ^{21}Ne(d,p)^{22} reaction at 3.3

NSA Vol. 26, No. 22, Abst. 53218, line four should read: This monitor, with a sensitivity of ~10^{-14} A/μR/hr and an unusual

Volume 27, Number 6, March 31, 1973

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Office of Information Services, John A. Harris, Director.
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Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

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Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications.

A list of the journals scanned regularly and the abbreviations used appears in the January 15 issue of *Nuclear Science Abstracts* and is supplemented in the July issue. The January 15 issue also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:10y3 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

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TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)
TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation counting, 25:40 (IDO-12073, pp 28-36)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

is indexed as:

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

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Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

11644 (HEDL-SA-426) SYNOPSIS OF ORAL PRESENTATION ANALYTICAL CHEMISTRY PROGRAMS AT THE HANFORD ENGINEERING DEVELOPMENT LABORATORY. Alkire, G. J.; Hartcorn, L. A.; Matsumoto, W. Y.; Moore, R. L. (Hanford Engineering Development Lab., Richland, Wash.). 13 Sep 1972. Contract AT(45-1)-2170. 32p. (CONF-721025-13). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN (24 Oct 1972).

The major function of the analytical laboratory at HEDL is the characterization of materials both before and after irradiation in support of the FFTF/LMFBR program. The key reactor core components requiring characterization are mixed UO_2–PuO_2 fuel, boron carbide absorber material, stainless steel cladding, and sodium coolant. The characterization capabilities are categorized into compositional analyses, microstructural analyses, impurities and defect analyses, and post irradiation analyses. (D.H.M.)

Analytical Chemistry

Refer also to abstracts 12193, 12198, 12199, 12216, and 12442.

11645 TRACE ANALYSIS TECHNIQUES FOR SOLIDS. Kane, P. F.; Larrabee, G. B. (Texas Instruments Inc., Dallas). Annu. Rev. Mater. Sci.; 2: 33-68(1972).

A review of trace analysis technique for solids is presented tha covers direct techniques that do not require dissolution of the sample. Bulk methods considered are emission spectrography, activation analysis, mass spectrometry, and x-ray fluorescence. The surface and films methods considered are electron probe microanalysis, atom probe field ion microscope, Auger spectroscopy, ion-scattering spectrometry, ion probe microanalysis, and electron spectroscopy for chemical analysis. (D.H.M.) (143 references)

11646 ANALYTICAL CHEMISTRY OF MOLYBDENUM AND TUNGSTEN (INCLUDING THE ANALYSIS OF THE METALS AND THEIR ALLOYS). Elwell, W. T.; Wood, D. F. International Series of Monographs in Analytical Chemistry. Oxford; Pergamon Press (1971). 276p.

The subject is dealt with in chapters: history, occurrence and applications of molybdenum and tungsten; physical and chemical properties; sampling and decomposition; qualitative detection; separations in the determination of molybdenum and tungsten; gravimetric methods; titrimetric methods; colorimetric methods; polarographic, amperometric, and coulometric methods; emission spectroscopic methods; atomic-absorption methods; x-ray spectrometric methods; radiochemical and mass-spectrometric methods; miscellaneous methods (polarimetry, infrared spectroscopy, eddy current/electric conductivity, electrographical method, differential thermal analysis, thermometric method, electron-beam microprobe analysis, electrochemical method); determination of impurities and alloying elements. A list of references is appended to each chapter. (UK)

11647 DETERMINATION OF HYDROGEN IN MOLYBDENUM BY A DIFFUSION-MANOMETRIC METHOD. Petushkov, E. E.; Tserfas, A. A.; Maksumov, T. M. pp 107-9 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A leak system including a nickel tube is used. As the diffusion coefficient of H in Ni is much greater than that of the other gases, it can be assumed that only H passed through the Ni. The sensitivity is on the order of 5×10^{-5}% for a sample weight of 30 to 40 g. The relative error for a H content of 5×10^{-4}% is 5%. (DLC)

11648 MINOR ELEMENTS IN COAL: A SELECTED BIBLIOGRAPHY, JULY 1972. Averitt, Paul; Breger, I. A.; Swanson, V. E.; Zubovic, Peter; Gluskoter, H. (comps.). U. S. Geol. Surv., Prof. Pap.; No. 800-D, 169-171(1972).

A bibliography of 65 selected references on trace elements in coal is presented as a guide to available information and as an aid to further study. Most of the cited reports are in English and most are applicable to the United States. (auth)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 12591, 13483, and 13551.

11649 (AERE-R-6724) STUDIES OF THE ANALYSIS OF AIRBORNE PARTICULATE MATERIAL BY RADIOACTIVATION AND SODIUM IODIDE SPECTROMETRY. Atkins, D. H. F.; Fisher, E. M. R.; Salmon, L. (Atomic Energy Research Establishment, Harwell (England)). Oct 1972. 25p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The application of instrumental neutron activation analysis with computer resolution of gamma spectra to airborne particulate material was studied. An improved method for preparation of standards and flux monitors is described and recoveries for the elements investigated were measured under realistic conditions. A description of the computational analysis of scintillation spectra is included and simulation techniques were used in an investigation into the effect of instrumental instability on the analysis. (auth)

11650 (CEA-CONF-2117) DETERMINATION OF ^{237}Np IN TRACE AMOUNTS IN URANIUM AND PLUTONIUM. Guay, P.; Pinelli, F. (Commissariat a l'Energie Atomique, Paris (France)). [nd]. 9p. (In French). (CONF-721010-13). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The ^{237}Np contained in samples of ^{238}Pu or ^{239}Pu is determined by γ spectrometry of the ^{238}Np produced by thermal neutron activation. The measurement is carried out directly on the irradiated samples in the case of ^{238}Pu and after chemical separation in the case of ^{239}Pu. The content of ^{237}Np in samples of natural uranium is determined directly by measurement of the ratio of the alpha activities of ^{238}Pu and ^{239}Pu formed after neutron irradiation and decrease of the Np isotopes produced by activation of the ^{237}Np and ^{238}U. (tr-auth)

11651 (CEA-CONF-2121) RAPID NEUTRON ACTIVATION OF BROMINE USING 6.1-MINUTE ^{82m}Br: APPLICATION TO THE DETERMINATION OF BROMINE IN BLOOD PLASMA. Peisach, M.; Maziere, B.; Loc'h, C.; Comar, D.; Kellershohn, C. (Southern Universities Nuclear Inst., Faure (South Africa). Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 10p. (CONF-721010-18). Dep. NTIS (U. S. Sales Only).

From International Conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A rapid method is described for the determination of bromine in blood plasma using neutron activation analysis. By measuring ^{82m}Br with x-ray spectrometry, analyses of 10 μl aliquots of

plasma can be carried out within 10 minutes. Bromine sensitivity, in the presence of the large concentrations of sodium and chlorine normally found in plasma, is about 5 ng. Apart from statistical errors, the experimental error introduces a relative precision uncertainty of about ±2%. The use of different detectors is compared. (auth)

11652 (CEA-CONF-2122) NEUTRON ACTIVATION ANALYSIS OF SOLID ATMOSPHERIC POLLUTANTS WITH AN INTERNAL STANDARD TECHNIQUE. Belot, Y.; Marini, T. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 14p. (In French). (CONF-721010–14). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A nondestructive technique is described that permits the determination of about 20 elements in atmospheric particles collected on a filter. A known quantity of rubidium, which serves as an internal standard, is deposited on the unknown sample. The unknown sample and the reference sample are irradiated under the same conditions for several days in a thermal neutron flux and then counted by a Ge(Li) detector. The advantages and limitations of the internal standard technique are discussed. (tr-auth)

11653 (CEA-CONF-2123) EXACT LOCALIZATION OF FLUORINE ON POLLUTED NEEDLES OF ABIES ALBA BY MICROANALYSIS WITH PROTONS. Garrec, J. P.; Ligeon, E.; Bontemps, A.; Bligny, R.; Fourcy, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 9p. (In French). (CONF-721010–12). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Nuclear reaction microanalysis is used to study the distribution of polluting elements in plants. Thus the direct detection of alpha radiation from the reaction $^{19}F(p,\alpha)^{16}O$ is a means of observing quantitatively the distribution of fluorine accumulated by the polluted needles of Abies alba. By this technique, which makes it possible to measure the quantity of fluorine distributed near the surface, two distinct sites for the accumulation of fluorine have been ascertained: the first at the dead point of the needle, the second in the narrow band of tissues between the healthy tissues and the dead tissues. The distribution of the fluorine along the needle and the measured contents differ according to the face considered: the upper face is more polluted than the lower face. The age of the needles affects, on the other hand, the amount of accumulation of fluorine. (tr-auth)

11654 (CEA-CONF-2128) MEASUREMENT OF CARBON AND OXYGEN IN SODIUM AND CESIUM THROUGH ACTIVATION BY MEANS OF GAMMA PHOTONS. Nordmann, F.; Tinelli, G. (Ecole Superieure de Chimie, Mulhouse (France)); Engelmann, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 35p. (In French). (CONF-721010–16). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Improvements are presented for determining very small amounts of carbon and oxygen in sodium or cesium. These two elements can be determined by the following nuclear reactions $^{12}C(\gamma,n)^{11}C$ and $^{16}O(\gamma,n)^{15}O$, respectively. The chemical separation processes used for separating ^{11}C and ^{15}O are described. The influence of competitive nuclear reactions producing these same radioisotopes starting with other impurities or from the matrix in the case of sodium are discussed. Several examples of applications are given. These methods in particular have made it possible to determine oxygen in amounts of a few tenths of a $\mu g/g$ and carbon in an amount of about 1 $\mu g/g$ in sodium. The concentrations found in cesium are higher. The results are compared with those obtained by other methods. (tr-auth)

11655 (CEA-CONF-2129) SYSTEMATIC ANALYSIS OF TRACE ELEMENTS IN METALLIC GOLD BY NEUTRON ACTIVATION. May, Serge; Piccot, Denis; Pinte, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 10p. (In French). (CONF-721010–15). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A method for the determination of impurities in metallic gold by neutron activation has been improved. After irradiation for 15 hr in a flux of 2×10^{14} n/cm^2/sec, the sample of gold is treated in a shielded cell. The matrix is separated from the impurities to be determined by electrolytic methods. The impurities are generally separated into three fractions, which are examined by gamma spectrometry. The examination of the data is carried out on an IBM 360/91 computer using a program written in the laboratory. Twenty-nine elements can be detected by this method. (tr-auth)

11656 (ORO-3922-5) RESEARCH IN CHARGED PARTICLE ACTIVATION ANALYSIS. Final Report, February 1, 1971–July 31, 1972. Schweikert, E. A. (Texas Agricultural and Mechanical Univ., College Station). 1972. Contract AT(40-1)-3922. 12p. Dep. NTIS.

Deuteron and ^{3}He activation methods were developed for the determination of carbon. Sensitivities in the 1 to 10 ppB range can be attained. Three complementary approaches for the determination of sulfur were studied: (a) A simple nondestructive technique using $^{32}S(p,\alpha)^{29}P$, ($t_{\frac{1}{2}}$: 4.4 sec). This method was found to be adequate for rapid sulfur assays in organic materials at concentration levels of 0.01% or higher. (b) A method based on the reaction $^{32}S(p,n)^{32}Cl$, ($t_{\frac{1}{2}}$: 0.3 sec) which is again very rapid and nondestructive. This technique is applicable to a wide range of liquid or solid organic and inorganic samples for sulfur concentrations as low as 50 $\mu g/cm^2$. (c) A destructive procedure involving the measurement of ^{34m}Cl produced via $S(p,x)^{34m}Cl$ or $S(d,x)^{34m}Cl$. With this technique 0.1 ppM concentration levels can be reached. Studies for probing nondestructively the impurity distribution inside a sample lead to the concept of "Time Dependent Variable Energy Activation." Theoretical and experimental model studies on varying carbon impurity concentrations were carried out to explore the features and limitations of this approach. (auth)

11657 (STI/DOC-10/137) MERCURY CONTAMINATION IN MAN AND HIS ENVIRONMENT. Technical Reports Series No. 137. Symposium Held at Amsterdam, Netherlands, May 1967. (International Atomic Energy Agency, Vienna (Austria)). Jul 1972. 185p. (CONF-670560). IAEA $6.00.

Twelve papers presented at the conference are included. Separate abstracts were prepared for four papers. (M.C.G.)

For abstracts of individual papers see: 11669–11671 and 11697.

11658 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF AIRBORNE CONTAMINANTS USING Ge/Li DETECTORS. Hewitt, P. J. (Univ. of Bradford, Eng.). Ann. Occup. Hyg.; 15: No. 2-4, 341-8(Nov 1972).

The advantages of neutron activation analysis are discussed. Neutron irradiation of collected airborne contaminants followed by gamma ray spectrometry with semiconductor detectors such as those based on lithium drifted germanium (Ge(Li)) permits rapid, sensitive and accurate (and, if necessary, nondestructive) determination of many metallic elements in a single small sample. Errors associated with analytical techniques based on dissolution and chemical treatment are avoided, and the method is readily automated. Concentrations of several elements in urban air and in welding fumes are reported, including Co, Cr, Fe, Sb, and Zn in welding fumes. Other elements observed in urban air samples were Ba, Cl, Cs, Cu, Hg, Mn, Na, Sc, and Se. (auth)

11659 DETERMINATION OF TIN IN BIOLOGICAL MATERIAL BY USING NEUTRON-ACTIVATION ANALYSIS. Bowen, H. J. M. (Univ. of Reading, Eng.). Analyst; 97: No. 1161, 1003-5(Dec 1972).

A method for the determination of tin in biological material, by using neutron activation analysis and radiochemical separation of tin-121, is described. Decontamination from sodium and antimony was shown to be satisfactory by tracer techniques, and the method was applied to biological standard materials and other samples. The precision is ±10% at the submicrogram level, and the sensitivity (which could be lowered by increasing the neutron flux) was found to be 10 to 20 ng. (auth)

11660 NONDESTRUCTIVE ACTIVATION ANALYSIS OF TUNGSTEN IN LOW GRADE WOLFRAMITES AND STEELS. Iyer, C. S. P.; Parthasarathy, R. (Bhabha Atomic Research Centre, Bombay). Radiochem. Radioanal. Lett.; 12: No. 2-3, 201-5(29 Nov 1972).

A method for determination of tungsten in low-grade wolframites and steels by neutron activation analysis followed by γ spectrometry is described. The activity of ^{187}W is measured at 0.680 MeV; corrections are applied for the contribution of ^{24}Na activity in the case of low grade wolframites. The method is rapid, sensitive, and nondestructive. (auth)

11661 STUDY OF THE RETENTION BEHAVIOUR OF A PRECIPITATED CALCIUM FLUORIDE COLUMN. Roelandts, I. (Univ., Liege). Radiochem. Radioanal. Lett.; 12: No. 2-3, 89-96(29 Nov 1972).

A systematic investigation of the retention of 41 ions from 4N HCl on columns filled with precipitated calcium fluoride is de-

scribed. Scandium, yttrium, and hafnium, as well as sulfate, vanadate are sorbed on the column, whereas tantalum only partially. Retention capacities for the above ions were determined. The possibility of the application of this column for the separation of rare earth ions from geological matrices is pointed out. (auth)

11662 STUDY OF THE RETENTION OF MANGANESE ON CERIC OXALATE FOR THE PURPOSE OF THE ACTIVATION DETERMINATION OF SOME IMPURITIES IN TITANIUM. Blondiaux, G.; Vialatte, B. (CEN de Saclay, Gif-sur-Yvette, France). Radiochem. Radioanal. Lett.; 12: No. 2-3, 103-10 (29 Nov 1972). (In French).

The retention of manganese on cerium(III) oxalate in the presence of large amounts of titanium was studied. The separation of manganese from most of the impurities present in titanium can be achieved by this method. The determination of copper, nickel, and chlorine by activation analysis in titanium is possible on this basis. (auth)

11663 AUTORADIOGRAPHIC DETERMINATION OF LOCAL BORON DISTRIBUTION USING INDUCED RADIATION. Freyer, K.; Baumbach, H.; Hartmann, G. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Berlin). Radioisotopy; 13: No. 3, 589-95(1972). (In German).

Experimental investigations on the representation of boron diffusion profiles in semiconductors are reported, based on the possibility of visualization of local substance distribution in cases where no suitable radionuclide is available by means of induced autoradiography. A method of quantitative representation of the profiles is presented. (auth)

11664 SELECTIVITY IN THE APPLICATION OF ACTIVATION TECHNIQUES BASED ON THE MEASUREMENT OF PROMPT RADIATION EMITTED DURING CHARGED-PARTICLE IRRADIATION. Pierce, T. B. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Soc. Anal. Chem.; 9: No. 12, 278-9(Dec 1972).

Advantages of activation-analytical techniques based on the measurement of prompt radiation emitted during charged-particle irradiation are discussed. It is stated that although these techniques have not so far received much attention from analysts they offer a more extensive range than is available solely by measurement of induced radioactivity and different methods can be selected to match the needs of specific analytical problems. Prompt radiations measured are (a) γ-radiation, (b) charged particles and neutrons from nuclear reactions, (c) elastically scattered particles and (d) x-rays. Techniques were initially devised to provide gross information about the elemental content of the sample irradiated, but more refined methods have since been developed that permit (i) information to be obtained from small volumes of sample by irradiating with small-diameter ion beams, (ii) examination of subsurface element profiles by using resonance and other effects that can be made depth sensitive and (iii) structures of some single crystals to be investigated by making use of the effect of channelling. The reactions involved in each category are discussed, and selected examples are presented of the application of the techniques. (UK)

11665 FAST NEUTRON ACTIVATION ANALYSIS OF SILICON USING INTERNAL STANDARD. Nakane, Masanori; Ishikawa, Hiroshi; Miyake, Yoshizo (Government Industrial Research Inst., Osaka). Jap. Anal.; 21: No. 11, 1485-90(Nov 1972). (In Japanese).

The determination of silicon by fast neutron activation depends on the $^{28}Si(n,p)^{28}Al$ ($T_{1/2}$ = 2.3 min; 1.78 MeV) reaction. The use of barium as the internal standard was investigated. Because the half-life of the ^{137m}Ba originated by the reaction $^{137}Ba(n,n')^{137m}Ba$ ($T_{1/2}$ = 2.6 min; 0.662 MeV) is nearly equal to that of ^{28}Al and the γ-ray energy of ^{137m}Ba differs sufficiently from that of ^{28}Al, the activity of ^{28}Al is easily normalized by referring to that of the internal standard. Barium as the internal standard served satisfactorily under varying experimental conditions, e.g., the neutron flux and the counting time. The internal standard method proposed here was applied to the determination of silicon in several organic silicon compounds. Effects of some interfering elements on the results were examined. (auth)

11666 NEUTRON ACTIVE ASSAY TECHNIQUES FOR NUCLEAR REACTOR FUEL. Matsuda, Yasuhiko; Murata, Tohru; Tamura, Toshiyuki; Kawai, Nawoyuki (Nippon Atomic Industry Group Co., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 11, 688-90(Nov 1972).

Nondestructive assay techniques for nuclear fuel were studied in simulation for various stages of fabrication, burnup cycle, and reprocessing by measured neutrons in neutron-induced fission. The neutrons for irradiating the samples were generated by bombarding a Li target with protons from the NAIG 4-MV electrostatic accelerator. In the case of thermal neutron irradiation, polyethylene was employed as moderator, and four methods are described for detecting fission neutrons. The response of fission neutrons to ^{235}U enrichment was measured for ^{235}U slightly enriched UO_2 fuel rods. The technical conditions of the neutron source, the method of irradiation, geometry, and the kind of fission neutron detector to be used were established by this study. (H.L.W.)

11667 NUCLEAR STUDY OF THE FLUORINE CONTAMINATION OF TANTALUM BY VARIOUS POLISHING PROCEDURES AND OF ITS BEHAVIOR DURING SUBSEQUENT ANODIC OXIDATION. Maurel, B.; Dieumegard, D.; Amsel, G. (Ecole Normale Superieure, Paris). J. Electrochem. Soc.; 119: No. 12, 1715-19(Dec 1972).

The fixation of fluorine in the film left on tantalum by chemical polishing in a $H_2SO_4-HNO_3-HF$ mixture was studied using microanalysis by the nuclear reactions $^{19}F(p,\alpha)^{16}O$ and $^{16}O(d,p)^{17}O$. Typically 2×10^{15} atoms/cm^2 of fluorine is found in films containing 20×10^{15} atoms/cm^2 of oxygen. Leaching in boiling water decreases the amount of fluorine by about 50%. On the other hand, the dissolution of these films in a NH_4F saturated 40% HF solution reduces the fluorine contamination to less than 1.5×10^{14} atoms/cm^2. Hence this double chemical treatment appears to be an effective procedure to obtain low fluorine contaminations on polished tantalum. Leached samples were anodically oxidized in a 5% ammonium citrate aqueous solution up to 90V at 1 mA/cm^2. It was found both by dissolution techniques and by the observation of the 872 keV narrow resonance of the $^{19}F(p,\alpha\gamma)^{16}O$ reaction, that, after oxide growth, the fluorine remains near the metal-oxide interface. The oxide growth laws for the various surface preparation procedures described were investigated. The presence of ^{19}F on the surface of tantalum seems to have little influence on the growth laws; the small changes induced are discussed in detail. (auth)

11668 ION-EXCHANGE BEHAVIOR OF MERCURY(II) IN MIXED SOLVENTS: SEPARATION FROM ZINC(II), CADMIUM(II), GOLD(III), AND THALLIUM(III). Gupta, C. B.; Tandon, S. N. (Univ. of Roorkee, India). Separ. Sci.; 7: No. 5, 513-25(1972).

Distribution coefficients of Zn(II), Cd(II), Au(III), Hg(II), Tl(I), and Tl(III) between cation- and anion-exchangers Amberlite IR-120 and Amberlite IR-400, and aqueous solutions containing nitric or hydrochloric acid and organic solvents were determined as a basis for separation in determination of mercury by neutron activation. The organic solvents were methanol, acetone, and tetrahydrofuran. The separation of Hg(II) from Zn(II), Cd(II), Au(III), and Tl(III) was proposed in mixed solvents with high separation factors. Some of these separations were actually performed using column method. (auth)

11669 DETERMINATION OF MERCURY BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Guinn, V. P. (Univ. of California, Irvine). pp 87-97 of Mercury Contamination in Man and His Environment. Vienna; International Atomic Energy Agency (1972).

From Mercury contamination in man and his environment conference; Amsterdam, Netherlands (May 1967). See STI/DOC-10/137; CONF-670560.

High-flux thermal-neutron activation analysis can be used in its purely instrumental, nondestructive form to measure mercury levels as low as 0.01 ppM. It is shown that the most sensitive determination is attained by detection of the induced 65-hr ^{197}Hg activity. Examples of mercury determination in fish and grain are given. (M.C.G.)

11670 DETERMINATION OF MERCURY AND ITS COMPOUNDS BY DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS. Westermark, T. (Royal Inst. of Tech., Stockholm); Ljunggren, K. pp 99-110 of Mercury Contamination in Man and His Environment. Vienna; International Atomic Energy Agency (1972).

From Mercury contamination in man and his environment conference; Amsterdam, Netherlands (May 1967). See STI/DOC-10/137; CONF-670560.

Instances in which destructive neutron activation analysis is preferable for determination of mercury are discussed and various methods are compared. Applications of the method are described. (M.C.G.)

11671 RELIABILITY OF MERCURY ANALYSIS IN ENVIRONMENTAL SAMPLES. RESULTS OF AN INTERCOMPARISON ORGANIZED BY THE IAEA. Heinonen, J.; Merten, D.; Suschny, O. (International Atomic Energy Agency, Vienna). pp 137-41 of Mercury Contamination in Man and His Environment. Vienna; International Atomic Energy Agency (1972).

From Mercury contamination in man and his environment conference; Amsterdam, Netherlands (May 1967). See STI/DOC-10/137; CONF-670560.

Two different samples of flour were used in the intercomparison of methods for determination of mercury in biological materials.

Twenty laboratories participated using both destructive and non-destructive activation methods and chemical methods. Results in the ppM range were satisfactory, but were not that good in the ppB range. (M.C.G.)

11672 NEUTRON ACTIVATION ANALYSIS OF TRACE AMOUNTS OF RHENIUM IN ROCKS BY SUBSTOICHIOMETRIC EXTRACTION WITH 8-MERCAPTOQUINOLINE. Nadkarni, R. A.; Haldar, B. C. (inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 12: No. 4-5, 223-233(20 Dec 1972).

Subnanogram amounts of rhenium in rocks were determined by thermal neutron irradiation followed by substoichiometric extraction of the rhenium complex with 8-mercaptoquinoline into chloroform from a solution of at least 7M in HCl. (auth)

11673 DETERMINATION OF GALLIUM IN ROCKS BY NEUTRON ACTIVATION AND SUBSTOICHIOMETRIC EXTRACTION WITH MALACHITE GREEN. Nadkarni, R. A.; Tejam, B. M.; Haldar, B. C. (Inorganic and Nuclear Chemistry Lab., Bombay). Radiochem. Radioanal. Lett.; 12: No. 4-5, 235-244(20 Dec 1972).

Trace amounts of gallium were determined in a series of six standard rocks by thermal neutron activation and extraction with substoichiometric amounts of Malachite Green into benzene. The method is highly selective. (auth)

11674 ANALYSIS OF Cu, Zn, Fe, AND Si IN Cu/Zn ORE FLOTATION PRODUCTS BY FAST NEUTRONS. Bibby, D. M.; Sellschop, J. P. F. (Univ. of the Witwatersrand, Johannesburg). Radiochem. Radioanal. Lett.; 12: No. 4-5, 245-257(20 Dec 1972).

A technique for the analysis by fast neutrons of Si, Fe, Cu, and Zn in Cu/Zn ore flotation products was developed. Cu and Zn were determined by counting the 0.511 MeV annihilation peak at two different times and solving for the contribution of Cu and Zn activities either simultaneously, or by using an iterative method. (auth)

11675 DETERMINATION OF TITANIUM BY 14 MeV INAA IN THE ASH OF HUMIC PREPARATIONS. Bornemisza-Pauspertl, P.; Szilagyi, M. (Inst. of Nuclear Research, Debrecen, Hungary). Radiochem. Radioanal. Lett.; 12: No. 4-5, 271-276(20 Dec 1972).

The titanium content of humic ash samples was determined by nondestructive activation analysis using 14-MeV neutrons. The $^{47}Ti(n,p)^{47}Sc$ reaction gave 0.7 ± 0.05 w/w%, while the colorimetric measurement 0.73 ± 0.03 w/w% for the Ti content. (auth)

11676 CONTINUOUS ACTIVATION ANALYSIS OF SOLUTIONS USING THE CHERENKOV COUNTER. Kartashev, E. R.; Chulkin, V. L.; Shtan, A. S. (Atomic Energy Committee, Moscow). Radiochem. Radioanal. Lett.; 12: No. 4-5, 277-281(20 Dec 1972).

A Cherenkov counter was used for the continuous activation analysis of solutions containing β-emitting isotopes, as Li, F, In, Na, V, Se, and I. (auth)

11677 INCREASED SELECTIVITY IN CONTINUOUS ACTIVATION ANALYSIS. Anisimov, B. V.; Kartashev, E. R.; Markun, N. Yu.; Chulkin, V. L.; Shtan, A. S. (Atomic Energy Committee, Moscow). Radiochem. Radioanal. Lett.; 12: No. 4-5, 283-288(20 Dec 1972).

A method is described for the continuous analysis of solutions by activation wi[illegible] neutrons of different energies, using a single source of fast neutrons. (auth)

11678 MEASUREMENT OF ^{18}O CONCENTRATION PROFILES USING RESONANT NUCLEAR REACTIONS. Neild, D. J.; Wise, P. J.; Barnes, D. G. (Univ. of Manchester, Eng.). J. Phys., D (London); 5: 12, 2292-9(Dec 1972).

A procedure is described for determination of ^{18}O diffusion profiles from data taken using the nuclear reaction $^{18}O(p,\alpha)^{15}N$. A Van de Graaff generator is used as a source of protons. Three types of concentration profile for the reacting species are considered: a step function, an error function, and a thin-film-diffusion function. These are convoluted with functions that represent the spread and straggling of the proton beam, and the shape of the resonance capture cross section. The fit with the measured curve of resonant alpha yield against proton energy is estimated by a χ^2 analysis. The concentration profile parameters are varied so as to minimize χ^2. The analysis proved successful in measuring oxide thicknesses on chromium and oxygen diffusion profiles in TiO_2 and Cr_2O_3, and sample experiments are described. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 11792 and 12386.

11679 (ANL-7922, pp 29-60) CHEMISTRY OF IRRADIATED FUELS AND MATERIALS. Oct 1972.

In Chemical Engineering Division, fuels and materials chemistry semiannual report, January–June 1972.

An ion microprobe mass analyzer is being applied to the analysis of irradiated fuel. Analysis of irradiated stainless steel cladding has shown a very steep gradient in the oxygen content. Analysis of fission products in mixed-oxide fuel has shown that the instrument has excellent detection sensitivity for all fission products of interest. Electron probe microanalysis has been used to determine the molybdenum content in noble-metal inclusions and in the fuel matrix of four irradiated mixed-oxide fuels. The Mo–MoO_2 "redox-indicator" method has been applied to the data to determine the oxygen potential gradient in the columnar- and equiaxed-grain regions of these fuels. Laboratory experiments are being performed to assess the effects of selected cesium and molybdenum compounds on the mechanism of attack of stainless steel cladding. (auth)

11680 (ANL-Trans-921) X-RAY MICROANALYSIS OF THE OXIDE $(U-Pu)O_{2+x}$ SIMULATING DIFFERENT BURNUPS. Keroulas, F.; Calais, D.; Schmitz, F. Translated for Argonne National Lab., Ill., from Paper 9A of Panel on the Behavior and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7–11 August 1972. 13p. (CONF-720843-3). Dep. NTIS.

As a part of a program simulating the chemical state of a mixed oxide fuel $(U,Pu)O_2$ after irradiation, the corresponding oxides were analyzed at different burnups with the electron microprobe. Mixed oxides simulating burnups of 17 500, 50 000, 100 000, and 150 000 MWd/t were analyzed. Specimens containing certain fission products, suitably chosen to facilitate an interpretation of the reaction mechanisms between the fission products and the uranium/plutonium mixed oxide ($(U\,Pu)O_2$ + Mo, $(U\,Pu)O_2$ + Ru, $(U\,Pu)O_2$ + Ce + Ba + Zr, $(U\,Pu)O_2$ + $BaZrO_3$, and $U\,O_2$ + $BaZrO_3$), were also analyzed. The fission products showed three different types of distribution. Two types of metal inclusions were observed. The first type (called Φ_1) has the following average composition: Ru (55 ± 5%), Mo (35 ± 5%), Rh ≃ 10%, Pd ≃ 3%, and Re ≃ 3%. The second type (called Φ_2) consists of pure rhenium. Fission products were also observed in solution in the matrix and in the form of a gray phase containing barium and zirconium (Ba/Zr ratio ≃2) but no other fission product, nor uranium or plutonium. This phase is of the barium zirconate type $(BaO)_2ZrO_2$. With regard to the Φ_1 phase, an increase in the ratio of O/(U + Pu + soluble fission product) or of the temperature leads to oxidation of molybdenum. Moreover, heat treatments below 1600°C cause demixing with the appearance of a metal phase of the $(U,Pu)Pd_3$ type by reaction of the palladium with the mixed oxide. (auth)

11681 (CEA-R-4364) RESULTS OF AN INTERLABORATORY COMPARISON ON THE ANALYSIS OF Pu. (Commissariat a l'Energie Atomique, Paris (France)). Oct 1972. 22p. (In French). Dep. NTIS (U. S. Sales Only).

An interlaboratory comparison of determinations made of 11 elements (Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Si, Sn) in a sample of Pu is presented. The comparison was made in order to verify the applicability of the methods employed and the quality of the samples used. The results obtained for each element and the regrouped results demonstrate, in general, a satisfactory agreement between the participating laboratories. However, further work is required for Al and Si. (auth)

11682 (EURISOTOP-71) CHEMICAL METHODS FOR DETERMINING OXYGEN IN NON-FERROUS METALS. Kraft, G. (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). Sep 1972. 27p. Dep. NTIS (U. S. Sales Only).

Chemical isolation and reaction methods of determining oxygen in nonferrous metals are compared. The isolation methods considered are volatilization of the metal matrix by distillation, reaction volatilization of the metal matrix, and selective dissolution of the metal matrix. The reaction methods considered are hydrogen reduction and heat extraction. Eurisotop methods for determining oxygen in copper and its alloys, lead and its alloys, aluminum and its alloys, zirconium and its alloys, niobium, tantalum, molybdenum, alkali metals, germanium, silicon, and selenium are also presented. (D.H.M.)

11683 (RCN-178) DETERMINATION OF CHLORINE AND FLUORINE IN URANIUM DIOXIDE. van Raaphorst, J. G.; Tolk, A.; Lingerak, W. A.; Groen, A. J. P. (Reactor Centrum Nederland, Petten). Jun 1972. 17p. Dep. NTIS (U. S. Sales Only).

The separation of chlorine and fluorine from uranium dioxide by means of pyrohydrolysis is described. After separation those elements are determined by means of spectrophotometric methods. The apparatus used for the pyrohydrolytic separation contains a few modifications that result in a highly efficient separation of the chlorine and fluorine. Recovery experiments are described. (auth)

11684 DETERMINATION OF Nd AND Sm IN STANDARD ROCKS BY DOUBLE SPIKE ISOTOPE DILUTION METHOD OF

THE MASS SPECTROMETRY. Notsu, K.; Mabuchi, H.; Ozima, M. (Tokyo Univ.). Jap. Anal.; 21: No. 10, 1343-8(Oct 1972). (In Japanese).

With a view to applying the long-life radioactive nuclides, ^{147}Sm ($T_{1/2} = 1.06 \times 10^{11}$y) and ^{146}Sm ($T_{1/2} = 1.06 \times 10^{8}$y) to cosmochemical problems, a precise determination of Sm and Nd abundances by the mass spectrometric "double spike" isotope dilution technique was tried. This is an improved method of the ordinary "single spike" isotope dilution method and has an advantage of being able to correct the mass fractionation effect during mass spectrometric analysis. In the case of Sm determination a mixed spike solution containing enriched ^{148}Sm and ^{149}Sm was added to the sample and ^{147}Sm, ^{148}Sm, and ^{149}Sm mass peaks were measured. As to Nd, enriched ^{144}Nd and ^{146}Nd were used as spikes, and ^{142}Nd, ^{144}Nd, and ^{146}Nd mass peaks were measured. In order to eliminate interfering ion peaks, Nd and Sm were separated from other elements by 3 steps of ion exchange procedures. In the 1st, all rare earth elements were separated from other elements. In the 2nd, Sm and successively Nd were isolated from other rare earth elements. Nd and Sm in the form of lactate complex were separated from the lactate anion by the 3rd cation exchange column. Nd or Sm was converted to perchlorate and loaded on the tantalum filament of mass spectrometer. Mass spectra of Nd were obtained with the filament current of about 2.6A in the form of NdO^+, while Sm was measured with about 2.5A in the form of Sm^+. Abundances of Nd and Sm in four USGS standard rocks were determined. Results agree within 10% with those obtained by other isotope dilution analyses. (auth)

11685 ZINC ANALYSIS IN LAND WATER SAMPLES BY RADIOISOTOPE DILUTION METHOD. Kusaka, Yuzuru; Ozaki, Tomio (Konan Univ., Kobe, Japan). Jap. Anal.; 21: No. 10, 1352-8(Oct 1972). (In Japanese).

The zinc contents in several land water samples were determined by substoichiometric radioisotope dilution analysis. The water samples were filtered through millipore filter of the pore size 0.45 μ and were stored in polyethylene bottles after an addition of 100 ml of 6N HCl per 20 liter sample. A definite amount of ^{65}Zn tracer was added to each 1 liter sample and transition elements, such as zinc, lead, cobalt, and cadmium, in the sample were adsorbed on a cation exchange resin. The zinc in the 0.1N NaOH eluate was extracted substoichiometrically with a definite amount of dithizone-CCl_4 solution (0.001% w/v, 5 ml) at pH 8.0 and, at the same time, the zinc in the ^{65}Zn tracer solution used in the experiment was also extracted with the same amount of the dithizone-CCl_4 solution. The radioactivities (a_2 and a_1) in both extracts were measured separately by a NaI(Tl) scintillation counter and the zinc content (y_x) in the sample water was calculated. The zinc content (y_1) of the tracer used was determined by a conventional colorimetric analysis, that is, dithizone extraction method. The above radioisotope dilution method enabled an accurate but rather easy analysis of zinc in water samples that contained 10 to 150 μg Zn per liter. A direct method using no preconcentration procedure gave relatively inaccurate results and it was apt to be interfered with by unknown constituents. (auth)

11686 MASS FRAGMENTOGRAPHY AS AN APPLICATION OF GAS-LIQUID CHROMATOGRAPHY-MASS SPECTROMETRY IN BIOLOGICAL RESEARCH. Gordon, A. E.; Frigerio, A. (Istituto di Ricerche Farmacologiche Mario Negri, Milan). J. Chromatogr.; 73: No. 2, 401-17(22 Nov 1972).

The application of mass fragmentography, as a specific detector in gas-liquid chromatography, is reviewed. Uses for single ion detection and for multiple ion detection are described. Determination of stable isotopes, either added as tracer or naturally occurring for metabolic studies is discussed. (M.C.G.)

11687 SPECTRAL ANALYSIS OF SAMPLES OF COMPLEX COMPOSITION. Yudelevich, I. G.; Cherevko, A. S.; Bogdanova, E. S. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR., No. 9, Ser. Khim. Nauk; No. 4, 83-8 (Jul 1972). (In Russian).

The influence of different amounts of NaCl, RbCl, and SiO_2 on the line intensity of Mg, Be, Cr, Ni, V, Sb, and La was studied. It was found that substance composition affects the absolute line intensity very much. The influence is expressed through the change of degree of ionization. However, the relative line intensity is changed insignificantly with change of substance composition. The selection of appropriate buffer, which may stabilize ionization processes, allows analysis of the samples of complex composition on the single standard. (auth)

11688 HIGH RESOLUTION ISOTACHOPHORESIS BY MEANS OF DIRECT CONDUCTIVITY MEASUREMENTS WITH MINIATURE SENSING ELECTRODES. Everaerts, F. M.; Verheggen, Th. P. E. M. (Univ. of Tech., Eindhoven, Netherlands). J. Chromatogr.; 73: No. 1, 193-210(8 Nov 1972).

A detection system for analytical isotachophoresis, the conductivity detector, is described. This detector excels in its high resolving power, by means of which the time required for analysis is reduced enormously and the detectable amount of sample is decreased by a factor of at least 10. A possible explanation is given for most artifacts that are connected with this method of detection. Among the elements determined by this method are Cs and Sr. (auth)

11689 MINIATURE FLOW FLUOROMETER FOR LIQUID CHROMATOGRAPHY. Thacker, L. H. (Oak Ridge National Lab., TN). J. Chromatogr.; 73: No. 1, 117-23(8 Nov 1972).

A miniature flow fluorometer was developed for use as a detector in liquid chromatograph systems. Excitation wavelengths can be chosen among the low-pressure mercury lines by a choice of filters; emission wavelengths between 310 and 650 nm can be observed, and the accepted emission spectrum can be limited by blocking filters. The instrument is presently in use in the Body Fluids Analyses Program of the Oak Ridge National Laboratory in a new system developed to monitor classes of compounds previously difficult to detect in chromatograph eluates. In this service the instrument will detect well-separated organic acids present to the extent of 100 to 500 ng in the injected sample. (auth)

11690 HANDBOOK OF THE ANALYTICAL CHEMISTRY OF RARE ELEMENTS. Busev, A. I.; Tiptsova, V. G.; Ivanov, V. M. New York; John Wiley and Sons, Inc. (1970). 412p. $20.00.

Translation of Prakticheskoe Rukovodstvo po Analiticheskoi Khimii Redkikh Elementov by J. Schmorak.

The analytical chemistry of the following rare elements is discussed: lithium, rubidium, cesium, beryllium, scandium, yttrium, lanthanum, the lanthanides, thorium, uranium, titanium, zirconium, hafnium, vanadium, niobium, tantalum, molybdenum, tungsten, rhenium, gallium, indium, thallium, germanium, bismuth, selenium, and tellurium. (E.R.B.)

11691 POSSIBILITY OF USING Ag_2S CERAMIC MEMBRANE-ELECTRODE FOR THE DETERMINATION OF THE CONCENTRATION OF SOLUTIONS IN FLOW CONDITIONS. CHROMATOGRAPHIC DETECTOR. Liteanu, C.; Popescu, I. C.; Nascu, H. (Babes-Bolyai Univ., Cluj). Rev. Roum. Chim.; 17: No. 9, 1615-19(Sep 1972).

An attempt to use the Ag_2S ceramic membrane electrode to determine the concentration of flowing electrolyte solutions is described. This device can also be used as a liquid chromatographic potentiometric detector, as it responds to all the chemical species interacting chemically with Ag^+ or S^{2-} (such as I). The electric signal of the detector may be recorded without any previous changes by a high input impedance potentiometric recorder. (auth)

11692 DIRECT COULOMETRIC TITRATION OF URANIUM (VI) WITH ELECTROLYTICALLY GENERATED CHROMIUM(II) IN PRESENCE OF THORIUM AND ZIRCONIUM. Neshkova, M. T.; Sheytanov, H. E.; Shoshlekova, E. M. (Inst. of General and Inorganic Chemistry, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 7, 945-8(1972).

The proposed coulometric method permits a quick and accurate determination of U(VI) on μg and mg scales. The maximum number of determinations in the same catholyte is 20. The two valency states of U(VI and IV) can be differentiated. The maximum U(VI) : Th(IV) ratio was 1 : 100 at 3.4 mg U^{6+} titrated and the maximum U(VI) : Zr(IV) ratio was 1 : 10. (MCG)

11693 TITRIMETRIC DETERMINATION OF IRON(II), MOLYBDENUM(V), AND THALLIUM(I) WITH POTASSIUM CHLORATE USING REDOX INDICATORS. Gopala Rao, G.; Radhakrishnamurty, C. (Andhra Univ., Waltair, India). Bull. Chem. Soc. Jap.; 45: No. 11, 3437-9(Nov 1972).

Accurate and convenient procedures were devised for the titrimetric determination of iron(II), molybdenum(V), and thallium(I) with potassium chlorate using visual indicators. These procedures are more advantageous than the procedures involving bromate. Further, chlorate is to be preferred as it is more inexpensive than bromate or iodate. Potassium chlorate is now obtainable at the purity required of a primary standard at a nominal cost. The chlorate titration procedure for iron(II) works satisfactorily even in the presence of organic materials such as oxalic acid, tartaric acid, and citric acid, so that it can be used for the determination of ferrous iron in pharmaceutical preparations or of ferric iron after reduction. It has been observed by us that oxygen of the air interferes in the titration of iron(II) in 6 to 7 M hydrochloric acid medium using naphthol blue black or methyl orange as a redox indicator but not in the titration of iron(II) in sulfuric acid medium using ferroin as an indicator. An inert atmosphere is not necessary for the titration of molybdenum(V) and thallium(I) in hydrochloric acid medium. (auth)

11694 N-(β-HYDROXYETHYL)ANABASINE AS A FLUORESCING REAGENT IN DETERMINATION OF URANIUM. Maksimycheva, Z. T.; Talipov, Sh. T.; Zel'tser, L. E. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 6, 39-40(1971). (In Russian).

In the presence of uranyl ions and a pH of 9, the normal fluorescence of N-(β-oxyethyl)anabasine (OEO) is quenched. The quenching is believed to be the result of an inner complex of UO_2–OEA (ratio of metal : ligand = 1 : 2). The phenomenon was the basis for a proposed analytical determination of U, even in the presence of a 100-fold excess of Mo, W, Cr, Mn, a 50-fold excess of rare earths, and non-ferrous metals, and a 10-fold excess of Zr or Th. (K.S.W.)

11695 HIGH-TEMPERATURE PREMIXED FLAMES IN FLAME SPECTROMETRY. Rubeska, Ivan; Miksovsky, Miroslav (Ustredni Ustav Geologicky, Prague). Chem. Listy; 66: No. 11, 1191-1203(Nov 1972). (In Czech).

Some properties of high-temperature flames using nitrous oxide as an oxidant, which are important from the point of view of their analytical use, are reviewed briefly. Their ability to atomize the elements capable of forming thermostable oxides is mentioned. (45 references) (auth)

11696 FERROIN AS INDICATOR IN THE DICHROMETRIC TITRATION OF URANIUM(IV). Muralikrishna, U.; Bapanaiah, K. V. (Andra Univ., Waltair, India). Z. Anal. Chem.; 262: No. 1, 29-30 (1972).

The color change at the end point of the titration is quite sharp. Results suggested that the slower reaction between ferroins and uranium(IV) is induced by the faster uranium(IV) dichromate reaction, thereby enabling a satisfactory titration. (M.C.G.)

11697 DETERMINATION OF TRACES OF MERCURY BY SPECTROPHOTOMETRY, ATOMIC ABSORPTION, RADIOISOTOPE DILUTION, AND OTHER METHODS. Lamm, C. G.; Ruzicka, J. (Technical Univ. of Denmark, Lyngby). pp 111-30 of Mercury Contamination in Man and His Environment. Vienna; International Atomic Energy Agency (1972).

From Mercury contamination in man and his environment conference; Amsterdam, Netherlands (May 1967). See STI/DOC-10/137; CONF-670560.

Sample decomposition, separation and preconcentration of mercury, and the individual instrumental methods are reviewed. Results of these methods are evaluated and compared with neutron activation methods. (47 references). (M.C.G.)

11698 POTENTIOMETRIC DETERMINATION OF FREE NITRIC ACID IN THE TBP–KEROSENE–URANYL NITRATE SYSTEM. Skwara, W.; Chwastowska, J. (Inst. of Nuclear Research, Warsaw). Nukleonika; 17: No. 7-8, 371-6(1972). (In Polish).

An alkalimetric method was developed for determining free nitric acid in the TBP–kerosene–uranyl nitrate system. The end-point is recorded potentiometrically. The uranyl ions are complexed with ammonium sulfate prior to the titration. The method enables nitric acid to be determined within the concentration range of 0.02 to 0.5 M in solutions containing 25 to 200 mg U/ml. The results were quantitative and reproducible. (auth)

11699 DETERMINATION OF PRECIOUS METALS BY FLAME SPECTROMETRY METHODS. Sychra, Vaclav; Kolihova, Dana (Vysoka Skola Chemiko-Technologicka, Prague). Chem. Listy; 66: No. 10, 1009-26(Oct 1972). (In Czech).

Information on the determination of precious metals by all three methods of flame spectrometry (atomic absorption spectrometry, atomic fluorescence spectrometry, and emission flame spectrometry) is summarized and evaluated. Some data are supplemented by practical experiences of the authors. The main attention is devoted to the absorption method, which is the most current and also most elaborated. Reference is also made to the determination of trace amounts of precious metals by modern flameless techniques. Elements determined include Ag, Au, Pd, Pt, Rh, Ir, Ru, and Os. (216 references). (auth)

11700 SPECTROGRAPHIC DETERMINATION OF IMPURITIES Mg, Mn, Cr, Ni, Fe, AND Mo IN $LiNbO_3$. Tarasevich, N. I.; Zlomanova, G. G.; Voronkova, L. E. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 4, 443-5(1972). (In Russian).

A spectrographic method for the determination of impurities, Mg, Mn, Cr, Ni, Fe, and Mo, (about 1×10^{-1} to $5 \cdot 10^{-3}$%) in $LiNbO_3$ is suggested. (auth)

11701 METHOD AND DEVICE FOR X-RAY FLUORESCENCE MEASUREMENTS OF A SELECTED ELEMENT WITH HIGHER ATOMC NUMBER WITHIN A COATING OF AN UNDER LAYER. Hill, R. C. (to Minnesota Mining and Mfg. Co.). German Patent 1,798,125. 20 Jan 1972. (In German).

X-ray fluorescence analysis for the measurement of the amount and mass per unit area of a coating on an under layer which contains an element one atomic number higher than any other element contained in the coating or in the base is described. In certain cases there is a direct relationship between mass per unit area and thickness of the coating. Selective fluorescence measurements of this element can be realized by means of a filter consisting of a preselected element which (because of a defined thickness and a length of the x-ray absorption edge which lies a little bit below at least one of the characteristic wave lengths of the fluorescence radiation of the coating element) transfers the fluorescence radiation of the coating element with a known percentage of absorption whereas the percentage of the absorbed background fluorescence radiation is considerably higher. (GF)

Radiometric and Radiochemical Procedures

Refer also to abstracts 11862, 11980, 12111, 12135, 12150, and 12592.

11702 (ANL–7924) CHEMICAL ENGINEERING DIVISION BURNUP, CROSS SECTIONS, AND DOSIMETRY SEMIANNUAL REPORT, JANUARY–JUNE 1972. Larsen, R. P.; Dudey, N. D.; Crouthamel, C. E.; Tevebaugh, A. D.; Levenson, M.; Vogel, R. C. (Argonne National Lab., Ill.). Sep 1972. Contract W-31-109-eng-38. 48p. Dep. NTIS.

Research and development efforts of the burnup, cross sections, and dosimetry programs in the Chemical Engineering Division of Argonne National Laboratory are reported for the period January to June 1972. Work is reported in the following areas: development of an x-ray spectrometric method for the determination of the rare earth fission products and application of this method to the determinations of burnup in nuclear fuels; determination of fast fission yields of burnup monitors and other fission products; a search for a spontaneously fissioning isomer of ^{241}Pu; measurements of the tritium and alpha particle yields in fast-neutron fission of ^{235}U and ^{239}Pu; evaluations of available data on the differential cross sections for the $^{56}Fe(n,p)^{56}Mn$ and $^{32}S(n,p)^{32}P$ reactions; and measurements of both fission rates by solid-state track recorders and reaction rates by foil activation, in the Coupled Fast Reactivity Measurement Facility. (7 figures, 10 tables) (auth)

11703 (BNFL-Report-1) RAPID DETERMINATION OF PLUTONIUM IN URINE: SEPARATION FROM BAKED URINE RESIDUES USING ION-EXCHANGE. Bates, T. H.; Boyd, T. H.; Clarke, J. P. (British Nuclear Fuels Ltd., Risley (England)). 1971. 21p. Dep. NTIS (U. S. Sales Only).

A method is given for the determination of plutonium in urine within 4 hr of receipt of a sample, excluding counting time. The method consists of evaporating 250 ml of sample to dryness with nitric acid and baking at 550°C to remove organic matter, dissolution of the residue and removal of interfering condensed phosphates by boiling with a catalyst, isolation of the plutonium using an anion-exchange column and finally counting the plutonium on a tray in a low background counter. The method can be scaled up to cope with 11 samples of urine. The interference of condensed phosphates with the ion-exchange process is studied. It has been shown that the presence of iron in the analytical process promotes good recovery of plutonium. (auth)

11704 (Y–1861) ANALYSIS OF STAINLESS STEELS BY X-RAY FLUORESCENCE SPECTROSCOPY. McElhaney, R. J.; Morrow, R. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1 Dec 1972. Contract W-7405-eng-26. 15p. Dep. NTIS.

A method has been developed for the x-ray fluorescence determination of nickel, chromium, manganese, titanium, and silicon in stainless steel. Samples in the form of chips or turnings are melted in an arc furnace and the resulting button analyzed using an automated x-ray fluorescence spectrometer. The method has the advantages of being less time consuming and more precise than the atomic absorption and gravimetric procedures previously used. (auth)

11705 SEMICONDUCTOR DETECTOR X-RAY FLUORESCENCE SPECTROMETRY APPLIED TO ENVIRONMENTAL AND BIOLOGICAL ANALYSIS. Jaklevic, J. M.; Goulding, F. S. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 384-91(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The effective application of Si(Li) semiconductor x-ray detectors to the elemental analysis of trace impurities in environmental and biological specimens has required the improvement of existing systems. The use of low-background x-ray tubes for fluorescence excitation and the increased counting rate capability of the electronics have reduced counting times necessary for analysis. The presence of radiation-induced low-energy background in conventional detectors has been shown to be a major limiting factor in the

detection sensitivity for trace element constituents in organic specimens. The use of guard-ring detector geometries has eliminated the cause of much of this background, and has reduced detection limits by approximately an order of magnitude. The practical detection of 0.1 ppm concentration achieved with these techniques has made energy-dispersive x-ray fluorescence a potent tool for the analysis of environmental and biological samples. A few examples were chosen to emphasize particular advantages of the technique relative to alternative analytical methods. Examples include trace element determination in blood, air pollution particulate analysis, and studies of the influence of environment on the trace constituents of biological specimens. (16 figures) (auth)

11706 DETERMINATION OF NICKEL BY RADIOISOTOPE X-RAY FLUORESCENCE IN NICKEL OXIDE. Meitin, J. (National Scientific Research Centre, Havana). Radiochem. Radioanal. Lett.; 12: No. 2-3, 171-5(29 Nov 1972).

A quantitative analytical method is described for the determination of nickel at its final stage of production using a $^{3}H/Zr$ bremsstrahlung source and the characteristic fluorescence line of nickel. (auth)

11707 DETERMINATION OF THE IRON CONTENT OF LATERITIC ORES BY RADIOISOTOPE X-RAY FLUORESCENCE. Meitin, J.; Marrero, M. (National Scientific Research Centre, Havana). Radiochem. Radioanal. Lett.; 12: No. 2-3, 163-9 (29 Nov 1972).

The Radioisotope X-Ray Fluorescence Analyzer AH-1 used for determination of iron in lateritic ores is described. The device has three $^{3}H/Zr$ bremsstrahlung radioactive sources, three GM counters, scaler, and timer for time-control counting. The measurement is carried out by placing the powdered samples in a suitable container under the source-detector assembly, the corresponding count being compared with a pulse vs. iron percent calibration curve obtained from standard samples. (auth)

11708 COMPUTERIZED CONTOUR MAPPING APPLIED TO TWO-DIMENSIONAL RADIOCHROMATOGRAMS. Siem, T. O.; Prydz, S. (Univ. of Oslo). J. Chromatogr.; 73: No. 1, 183-92(8 Nov 1972).

A one- or two-dimensional radiochromatograph employing an electron multiplier detector was described earlier as a means of reducing the necessary detection time for chromatograms containing weak β-emitters as labels. As an alternative to the usually applied film detection method, this method was adapted to a system for digital read-out of the count numbers which are simultaneously punched out onto paper tape. These are obtained during standard integration intervals with the counter in fixed positions. These positions are set by an automatic stepped-motion program, which enables the complete chromatogram to be covered with a set of equally spaced parallel profile scans of intensity. The point intensity grid is thus obtained on a paper tape and can then be used as input to a computer, which is programmed to apply a two-dimensional smoothing to the set of recorded intensities. The resulting smoothed activity chart can then be reproduced in the form of a contour map, sufficiently detailed and with a one-to-one scale. An approximate evaluation of the individual spot activities is possible, as well as an accurate positioning of the spots in the chromatogram. This allows the recovery, after cutting out and elution, of the various labeled materials. (auth)

11709 QUANTITATIVE DETERMINATION OF GLUCOSE METABOLITES SEPARATED BY ISOTACHOPHORESIS IN TWO-DIMENSIONAL COMBINATION WITH ZONE ELECTROPHORESIS. Sjoedin, R.; Vestermark, A. (Univ. of Stockholm). J. Chromatogr.; 73: No. 1, 219-25(8 Nov 1972).

Experimental conditions used for separation of glucose metabolites by isotachophoresis in two-dimensional combination with zone electrophoresis were arranged so as to give good quantitative yields. Labeled compounds were used to investigate optimum counting conditions. ^{14}C was determined in 4 series of experiments. (M.C.G.)

11710 RADIO GAS CHROMATOGRAPHY BY COLLECTION OF RADIOACTIVE COMPOUNDS ISSUING FROM A GAS CHROMATOGRAPH ON A MOVING STRIP OF PAPER. Yardley, H. J.; Long, V. J. W. (Medical School, Birmingham, Eng.). J. Chromatogr.; 73: No. 1, 235-7(8 Nov 1972).

Radioactive compounds are condensed on a moving paper strip and subsequently counted, thus combining the sensitivity of a discontinuous counting system with the advantages of continuous operation as in a flow system. ^{14}C was determined. (M.C.G.)

11711 DETERMINATION OF FISSION PRODUCTS AND URANIUM ATOMS EJECTED FROM THE SURFACE OF URANIUM-ALUMINUM ALLOYS AND URANIUM METALS. Hashimoto, T. (Kyoto Univ.). Radioisotopes (Tokyo); 21: No. 11, 635-40(Nov 1972). (In Japanese).

The amount of fission products and uranium on an aluminum collector, which was placed near to U–Al alloys and U metals during the neutron irradiation, were determined by γ spectrometry using a Ge(Li) detector and by fission tracks on a muscovite. The ejection rate of fission products against ^{235}U atom in unit weight from U metals was evaluated to about 2.6 times higher than for U–Al alloys. This result was attributed to the difference of fission fragment ranges in these materials. From the amount of uranium and the total number of fission fragments on the collector , the uranium atoms knocked out by one fragment (applied thermal neutron fluence: 8.42×10^{16} cm^{-2}) were calculated to be 0.28 and 233 for U–Al alloys and U metals, respectively. The great difference between two materials implies that aluminum in U–Al alloys plays a very important role in retarding the ejection of uranium atoms from the surface. (auth)

11712 AIR POLLUTION ANALYSIS BY THE ENERGY DISPERSIVE X-RAY SPECTROMETRY USING RADIOISOTOPES. Tanemura, T.; Suita, H. (Rigaku Denki Co. Ltd., Tokyo). Radioisotopes (Tokyo); 21: No. 11, 641-7(Nov 1972). (In Japanese).

Energy dispersive x-ray spectrometry using radioisotopes was applied to the analysis of aerosol samples. Radioisotope sources, ^{238}Pu and ^{55}Fe, were used for the excitation of characteristic x-rays above 5 keV and below 5 keV, respectively. The spectrometer system is equipped with a Si(Li) detector whose resolution is 198 eV (FWHM) for Mn K_α x-rays. Aerosol samples were collected on glass fiber filters by means of an air sampler. K x-rays of S, Cl, Ca, Mn, Fe, Ni, Cu, Zn, and Br, and L x-rays of Pb were observed in the spectra emitted from aerosol samples. Quantitative analyses of S, Cl, Fe, Cu, and Pb were carried out. Thin polymer films containing wanted elements were made as the reference standards for the quantitative analyses. A method for the matrix correction using characteristic x-rays emitted from the glass fiber filter is proposed. This method, which is useful for samples of medium thickness, was applied for correcting x-ray intensities of S and Cl. As the experimental results, atmospheric concentrations of above elements in aerosol samples range in 0.9 to 5.2 $\mu g/m^3$ for S, 0.2 to 6.4 $\mu g/m^3$ for Cl, 0.6 to 7.0 $\mu g/m^3$ for Fe, 0.03 to 0.24 $\mu g/m^3$ for Cu and 0.10 to 0.70 $\mu g/m^3$ for Pb, respectively. Analytical results for Cu and Pb relate to results obtained by atomic absorption for Cu and polarography for Pb, with average differences of 0.063 $\mu g/cm^2$ for the concentration range from 0.2 to 2.0 $\mu g/cm^2$ of Cu and 0.36 $\mu g/cm^2$ for the concentration range from 0.6 to 6 $\mu g/cm^2$ of Pb, respectively. (auth)

11713 RADIOCHEMICAL DETERMINATION OF TRACES OF CERIUM BY ISOTOPIC EXCHANGE IN ORGANIC PHASE. Kratzer, K.; Stary, J.; Zeman, A.; Majer, V. (Technical Univ., Prague). Collect. Czech. Chem. Commun.; 37: No. 10, 3267-70(Oct 1972).

A new radiochemical method for selective determination of traces of cerium was developed. The method is based on isotopic exchange between cerium(III) and cerium(IV) chelates with di(2-ethylhexyl)phosphoric acid in toluene. (auth)

11714 SPECTROCHEMICAL ANALYSES CARRIED OUT WITH THE ALL-AUTOMATIC X-RAY FLUORESCENCE ANALYZER VRA 2. Kramer, Lothar. Jena Rev.; 17: No. 4, 159-65(1972).

The use of the all-automatic x-ray fluorescence analyzer VRA2 in the supervision and control of processes in various fields of industrial production is discussed. Some applications given include analysis of high-alloy steels, red brass, tin bronze, alumina, and glass frits. (D.H.M.)

11715 CROSS CONTAMINATION IN SIMULTANEOUS RADIOCHEMICAL DETERMINATION OF Sr AND Cs. Kodaira, K.; Tsumura, A. Radioisotopes (Tokyo); 21: No. 11, 659-63 (Nov 1972).

The degree of contamination of the Sr fraction with ^{137}Cs was 10^{-4} for the direct measurement of ^{90}Sr, and 10^{-6} after the removal of the Cs fraction by phosphomolybdate treatment. The addition of Cs as a hold back carrier had no effect. A large amount of Cs carrier inhibits the coprecipitation yield of Cs. The degree of contamination of the Cs fraction with radioactive Sr was 10^{-1} when ^{90}Sr coexisted; this contamination was mainly caused by the ^{90}Y daughter. The degree of contamination decreased down to 10^{-3} by a single application of oxalate treatment, and down to 10^{-4} by repetition of the treatment. ^{89}Sr having no radioactive daughter gave a value less than 10^{-2} without oxalate treatment; it gave 10^{-4} after the first oxalate treatment, that is the same value as that for ^{90}Sr after a second treatment. The use of Sr instead of Ca for precipitation of the radioactive fraction had no effect. (auth)

11716 ANALYTICAL CHARACTERIZATION OF SUBSTANCES BY CHARGED PARTICLE SCATTERING. Krivan, V. (Max-

Planck-Institut fuer Metallforschung, Schwaebisch Gmuend, Ger.). Z. Anal. Chem.; 262: No. 1, 1-28(1972). (In German).

A general and relatively detailed picture is presented of the utilization of charged particle scattering in the analytical characterization of materials with the aim of providing both an introductory and usefully practical look at this field. Significant developments in the analytical application of the elastic scattering of such heavy charged particles such as protons, α particles, and more heavier ions are considered. Rutherford's model of elastic scattering was applied to explain the physical principles of the method. Published and some unpublished information is used for evaluation of all experimental factors affecting mass resolution and sensitivity that characterize the method. The performance capabilities of different types of charged particle sources (accelerators and nuclides emitting α particles) and instruments providing energy spectra of scattered particles (semiconductor detectors and magnetic spectrographs) are compared. Two possible variants of this method, one using a thin and the other using a thick sample, are described. The advantages and limitations of both variants are discussed. This technique can provide information on all the elements in the sample simultaneously when they are heavier than the bulk element. Sensitivities in the ppM range are easily achieved, higher sensitivities are possible. In addition, the physical principles, instrumentation, and applications of the β backscattering technique are reviewed. This method is applicable only for analysis of simple, commonly two-component, systems, whereby the sensitivity of trace analysis cannot be normally achieved. (auth)

11717 QUESTIONS ON THE CLASSIFICATION OF INSTRUMENTAL NUCLEAR ANALYTICAL METHODS ACCORDING TO TYPES OF SECONDARY RADIATION. Egiazarov, B. G. Yadern. Priborostr.; No. 14, 89-96(1971). (In Russian).

Questions on the classification of instrumental nuclear analytical methods according to the type of secondary radiation registered were examined. It was shown that the detection and analysis of the secondary γ radiation and, above all, γ spectrometry guaranteed the most informative and sensitive measurements. The importance of the use in instrumental nuclear methods of analysis of the material of semiconductor γ spectrometers with high energy resolution was stressed. (tr-auth)

11718 STUDY OF THE ADSORPTION OF GAS MIXTURES ON THE IRRADIATED SURFACES OF SILICA GELS BY THE METHOD OF INFRARED SPECTROSCOPY. Abylyaev, Sh. A.; Alimova, L. Ya; Settarova, Z. S. pp 128-30 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The increased absorption of gases (H_2, O_2, N_2) in silica gel induced by gamma irradiation on high-frequency discharge was studied by infrared spectroscopy using a vacuum adsorption cuvette. Results indicate that the additional adsorption of O_2 and N_2 arising from the presence of H_2 is due to the development of free and combined OH groups and compounds of H with N forming N–H, NH_3^+, and NH_2^+ groups on the surface of the silica gel. (DLC)

11719 DETERMINATION OF TRACE YTTRIUM AND OTHER HEAVY METALS IN URINE BY X-RAY FLUORESCENCE SPECTROSCOPY. Long, R. A. (GTE Sylvania Inc., Towanda, PA). Amer. Ind. Hyg. Ass. J.; 33: No. 5, 343-345(May 1972).

An x-ray fluorescence method was developed for the determination of trace (0.02 to 100 ppM) yttrium in urine. The method consists in wet ashing the urine with nitric acid, coprecipitating the yttrium with calcium oxalate, collecting the precipitate on microfilter disks, and then determining the yttrium by x-ray fluorescence. The precision is adequate for clinical analysis. This method was necessitated because calcium, phosphate, and other metals in the urine interfere with spectrophotometric methods. (auth)

11720 URANIUM, THORIUM, AND LEAD CONCENTRATIONS IN THREE SILICATE STANDARDS AND A METHOD OF LEAD ISOTOPIC ANALYSIS. Tatsumoto, Mitsunobu; Knight, R. J.; Delevaux, M. H. U. S., Geol. Surv., Prof. Pap.; No. 800-D, 111-115(1972).

Isotope dilution analyses of uranium, thorium, and lead in two U. S. Geological Survey rock standards, BCR-1 and AGV-1, and those in a National Aeronautics and Space Administration (NASA) basalt (from Knippa, Tex.) standard showed that concentrations in BCR-1 are 1.73 ppM U, 5.99 ppM Th, and 13.56 ppM Pb, in AGV-1 are 1.96 ppM U, 6.27 ppM Th, and 36.53 ppM Pb, and in NASA basalt are 1.87 ppM U, 6.42 ppM Th, and 5.13 ppM Pb. A comparison of lead contents for BCR-1 and the original split indicates that the standard is contaminated by lead; however, homogeneity of the sample was established and variation of the concentration is less than 1%. A new technique for isotopic analysis of lead, the silica gel-phosphate method, was tested for analytical uncertainties. The lead isotopic composition for BCR-1 obtained by the method using double-spike fractionation correction is $^{206}Pb/^{204}Pb$ = 18.794, $^{207}Pb/^{204}Pb$ = 15.610, and $^{208}Pb/^{204}Pb$ = 38.660. (auth)

11721 RADIOCHEMICAL DETERMINATION OF PLUTONIUM IN ENVIRONMENTAL WATER SAMPLES. Golchert, N. W.; Sedlet, J. (Argonne National Lab., IL). Radiochem. Radioanal. Lett.; 12: No. 4-5, 215-221(20 Dec 1972).

A radiochemical separation procedure is presented for the determination of plutonium in large environmental water samples. The procedure is based on the coprecipitation of plutonium with calcium fluoride from an acid–fluoride medium followed by purification on an anion-exchange resin and electrodeposition for α-spectrometry. Chemical recoveries of added plutonium from samples up to 50 l have averaged 94%. The detection limit of plutonium-239 in 10-l samples is 0.5 fCi/l. (auth)

11722 SEQUENTIAL ION EXCHANGE SEPARATION OF HEAVY ELEMENTS AND SELECTED FISSION PRODUCTS FOR BURNUP MEASUREMENT. Natsume, H.; Umezawa, H.; Okazaki, S.; (and others) (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol.; 9: No. 12, 737-42(Dec 1972).

A sequential ion-exchange separation method was developed for use in burnup measurements of nuclear fuels. Group separation by anion-exchange resin column with hydrochloric acid solutions containing small amounts of nitric acid and hydrochloric acid was followed by various cation and anion exchange processes. The heavy elements, such as U, Np, and Pu, and some fission products selected as burnup monitors, such as Cs, Mo, and Nd, could be sequentially and quantitatively separated from a sample taken from spent fuel. The recovery of these elements through the separation processes was examined. The sampling ratio of an aliquot in reference to the whole fuel specimen was determined by adding as sampling monitor a known amount of Cu to the sample during dissolution. The validity of the ion-exchange separation technique for routine analysis for burnup measurements is also discussed. (auth)

Separation Procedures

Refer also to abstracts 12201 and 13993.

11723 (ORNL-TM-4000) SEPARATIONS PROCESSES. Water Research Program Biennial Progress Report for the Period March 15, 1966–March 15, 1968. Johnson, J. S. Jr.; Moore, G. E. (comps.) (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 170p. Dep. NTIS.

Research progress on hyperfiltration with dynamically formed membranes and on boundary layer phenomena is reported. Completed portions of the work have been published in journals and are reproduced directly in this report. (M.C.G.)

11724 BACK-EXTRACTION OF METAL CARBAMATES IN CHLOROFORM WITH ACID AND ALKALINE SOLUTIONS. Kuroha, Toshiaki; Shibuya, Seiji (Central Research Lab., Tokyo). Jap. Anal.; 21: No. 11, 1505-10(Nov 1972). (In Japanese).

Back extraction of 20 metal carbamates in chloroform with nitric acid, hydrochloric acid, and sodium hydroxide solutions is presented. The metal carbamates, Ag, As, Au, Bi, Cd, Co, Cu, Fe, Hg, In, Mn, Ni, Pb, Sb, Se, Sn, Te, Tl, V, and Zn, were investigated. Solutions of 0.5 to 4 N nitric acid, 1 to 6 N hydrochloric acid and 0.5 to 5 N sodium hydroxide were used for the back-extraction. In the case of the back-extraction with nitric acid solutions, As, Bi, and Zn at 0.5 N, Ag, Au, Cd, Cu, Mn, Ni, Pb, Sb, Se, Tl, and Te at 1 N, In at 2 N, and Hg at 4 N are extracted into the solution from the solvent containing these diethyldithiocarbamates, while Co at 4 N, and Hg and In at 0.5 N are not extracted. In the hydrochloric acid solutions, Bi, Mn, and Zn at 4 N, As, Cd, Pb, Sb, and Se at 5 N, and Ag, Au, Hg, In, and Tl at 6 N are extracted, while Co, Cu, and Ni at 6 N, Fe at 3 N, and Hg, In, and Pb at 2 N are not extracted. In the sodium hydroxide solutions, As, Bi, In, Se, Sn, and Zn at 0.5 N, Mn, and Sb at 1 N, and Pb and V at 3 N are extracted, while Ag, Co, Cu, Hg, and Ni at 5 N, and Te at 1 N are not extracted. In all the cases, other metal chelates are partially extracted into each back-extraction solution. (auth)

11725 REVERSED-PHASE PARTITION CHROMATOGRAPHY OF RARE EARTHS WITH A MIXTURE OF ORGANIC EXTRACTANTS. Cvjeticanin, N. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Chromatogr.; 74: No. 1, 99-105(6 Dec 1972).

The behavior of rare earths has been investigated on papers impregnated with a mixture of thenoyltrifluoroacetone and tri-n-octylphosphine oxide. The mixture of these extractants effects a greater increase in the retention of the rare earth elements than any of these components alone. The maximum value for log

$(I/R_F - I)$ is obtained at a fixed composition of the mixture. The compositions of metallic complexes and the apparent equilibrium constants for certain synergistic species have also been determined. (auth)

11726 POSSIBILITIES OF SEPARATION OF IONS ON ION EXCHANGE RESINS. Sopkova, Anna; Chomic, Jozef (Univ., Kosice, Czech.). Chem. Listy; 66: No. 11, 1150-77(Nov 1972). (In Slovak).

Information on ion exchangers is presented, including views on their structure and the resulting properties. The use of organic as well as inorganic ion-exchanging materials for the isolation of the ions themselves or of various groups of ions is reviewed. Typical uses are reviewed and analyzed, as for example the concentration of trace amounts of ions, fractionation of ions, and the elimination of interfering ions. (380 references) (auth)

11727 PREPARATION AND ION EXCHANGE PROPERTIES OF STANNIC FERROCYANIDE. Gill, J. S.; Tandon, S. N. (Univ. of Roorkee, India). J. Inorg. Nucl. Chem.; 34: No. 12, 3885-92(Dec 1972).

Stannic ferrocyanide samples have been prepared under varying conditions of precipitation; their properties, composition and ion exchange behavior are reported. The distribution ratios of some metal ions are given and several separations (Zr from Th, U from Th, and Ba from La) have been achieved. (auth)

11728 STUDIES OF V(V), Se(VI), Mo(VI), AND Re(VII) ION SORPTION WITH ION EXCHANGE RESINS FROM NITRIC ACID SOLUTIONS. Kazantsev, E. I.; Prokhorov, V. A.; Makarov, M. K. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 87-91(1972). (In Russian).

The adsorption on and leaching off of V(V), Se(VI), Mo(VI), and Re(VII) with Ampholyte AVKB-1×8 and anion exchange resin AV-17×8 were investigated. Mo(VI) was adsorbed at pH of 3 to 5 in a quantity that exceeded the ion exchange capacity measured in other ways. This phenomenon was explained by sorption of the ions as a polymeric complex. The introduction of carboxyl groups into the structure of a strongly basic anion exchanger impaired its ability to separate Re and Mo. (K.S.W.)

11729 THIN-LAYER CHROMATOGRAPHY OF METAL IONS ON MICROCRYSTALLINE CELLULOSE IN ETHER-14M NITRIC ACID MEDIA. Ishida, Koji; Miyazaki, Mitsuhiro (Kyorin Univ., Tokyo). Jap. Anal.; 21: No. 11, 1518-20(Nov 1972). (In Japanese).

The thin-layer chromatographic behavior of 45 metal ions on microcrystalline cellulose (Avicel SF) was surveyed in ether–14M nitric acid media. R_f values were measured as a function of the solvent volume ratio. More than half of the tested metal ions that were not extracted from nitric acid solution into ether remained at the starting points regardless of the solvent volume ratio, while several ions, gold(III), rhenium(VII), tin(IV), and uranium(VI) that were well extracted showed high R_f values. The others, possessing some extent of the possibilities of the extraction, exhibited increased R_f values with decreasing the solvent volume ratio. It can be expected that this rise of the R_f values suggests an increase of the abundance of the species available for the extraction. Inspection of R_f values of metal ions allowed many useful separations like mercury(II)–cadmium, thorium–zirconium–lanthanum, gold(III)–palladium(II)–platinum(IV), which had been difficult in both paper chromatography and cellulose thin-layer chromatography using ether–nitric acid media. These were easily achieved by using ether–14M nitric acid (1:1, v/v) as a developing solvent. (auth)

11730 EFFECT OF AN ULTRASONIC FIELD ON THE ELECTRODEPOSITION OF TELLURIUM FROM ALKALINE ELECTROYLTES. Kadyrov, R. K.; Rasulov, K. R. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 10, 42-3(1971). (In Russian).

A magnetostriction converter was used in conjunction with an electrolytic bath of special construction to obtain the electrodeposition of Te from a solution of pH 10 to 13 with 0.03 to 0.0003 A/cm² current density over the temperature range 20 to 60°C. The energy of activation for the electrode reaction was about 6,400 cal/mole without the application of ultrasonic vibrations and 4,300 cal/mole when deposition was accomplished at 17.5 kHz. (K.S.W.)

11731 LIQUID–LIQUID EXTRACTION OF MERCURY WITH HIGH-MOLECULAR-WEIGHT AMINES FROM IODIDE AND BROMIDE SOLUTIONS. Moore, F. L. (Oak Ridge National Lab., TN). Separ. Sci.; 7: No. 5, 505-12(1972).

Systems are described for the highly efficient solvent extraction of mercury with high-molecular-weight amines from aqueous iodide or bromide solutions. Mercury extracts essentially quantitatively at both the subnanogram and macro levels. The quaternary amines are especially attractive because of their ability to extract mercury from alkaline as well as acidic solutions. Regeneration of the amine solvent is readily achieved by stripping the mercury with alkaline solutions of cysteine. (auth)

11732 STUDIES ON PHOSPHORUS-CONTAINING ION-EXCHANGE RESINS. PART II. EQUILIBRIUM STUDIES AND SOME ANALYTICAL APPLICATIONS. Ramaswamy, R.; Krishnaswamy, N. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Indian J. Technol.; 10: No. 5, 189-94(May 1972).

The exchange equilibria of some phosphorus-containing resins based on styrene-furfuraldehyde with Pb^{2+}, Zn^{2+}, Cd^{2+}, Ca^{2+}, Mg^{2+}, and Th^{4+} were studied. The affinity of the resins for different ions studied was in the order: $H^+ > Pb^{2+} > Zn^{2+} > Cd^{2+} > Ca^{2+} > Mg^{2+} > Th^{4+}$. The relative distributions of these metallic cations in buffered media at different pH values were studied using these resins as well as standard resins. The affinity based on the values of distribution coefficients was in the order: $Pb^{2+} > Zn^{2+} > Cd^{2+} > Ni^{2+} > Th^{4+}$. The results obtained indicate the possibility of using these resins for chromatographic separation of different metal ions from their mixtures and for separation of divalent ions present in trace quantities from solutions containing large quantities of monovalent ions. Complete separation of Zn^{2+} and Cd^{2+} from Pb^{2+} from their binary solutions and almost quantitative separation of trace amounts of Cu^{2+}, Pb^{2+}, and Zn^{2+} from excess of monovalent ions could be effected. (auth)

11733 EXTRACTION OF AMERICIUM(III), CURIUM(III), AND EUROPIUM(III) BY A MIXTURE OF TRIOCTYLAMINE AND TRIBUTYL PHOSPHATE FROM NITRATE SOLUTIONS. Spivakov, B. Ya.; Zolotov, Yu. A.; Myasoedov, B. F.; Chmutova, M. K.; Kochetkova, N. E. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 12, 3334-40(Dec 1972). (In Russian).

Possible sources of synergism were examined in the extraction of metals from nitrate solutions by a mixture of cation and neutral extractants. The extraction of trivalent Am, Cu, and Eu by a mixture of trioctylamine nitrate with oxygen-containing compounds was studied. An increase in the distribution coefficient was not associated with a change in the activity of the extractants as a result of their mutual reaction. An increase was also independent of the nature of the cation of the salting-out agent. The observed synergistic effect was attributed to the extraction by the amine of the composite anion complex, which contained a metal ion in the inner sphere in addition to nitrate groups and molecules of the neutral extractant. (tr-auth)

11734 ANION EXCHANGE SEPARATION OF GALLIUM, VANADIUM, AND MOLYBDENUM IN ALKALINE SOLUTIONS. Matsui, H. (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 5, 127-9(May 1972). (In Japanese).

A method for the separation of gallium(III), vanadium(V), and molybdenum(VI) on ion-exchange resins was investigated in sodium hydroxide solutions. Distribution coefficients for these ions with strongly basic anion-exchange resins were measured at various concentrations of sodium hydroxide. These ions were adsorbed on the resins above pH 10.0, but the adsorbabilities of the ions were widely different. Gallium(III) was not adsorbed above pH 12.0. The distribution coefficients of vanadium(V) decreased sharply with the increase of sodium hydroxide concentrations in the range from pH 12.0 to 2.0 M, and vanadium(V) was not adsorbed in 2.0 M solution. The distribution coefficients of molybdenum(VI) decreased slowly in that concentration range. On the basis of these results, the following procedure is recommended: A solution containing 2.0×10^{-3} m mol of gallium(III), vanadium(V), and molybdenum(VI) respectively, was passed through an ion-exchange column, 10 × 110 mm, at the sodium hydroxide concentration below pH 12.0. These ions were all adsorbed on the resins. The gallium(III) was eluted with 25 ml of pH 13.0 sodium hydroxide solution and vanadium(V) was eluted with 20 ml of 2.0 M sodium hydroxide solution. The molybdenum(VI) was then eluted with 25 ml of 1:1 mixture of 1.0 M sodium hydroxide solution and 1.0 M sodium chloride solution. (auth)

11735 EXTRACTION OF RUBIDIUM AND CESIUM BY BENZOYL ACETONE. Magomedbekov, U. G.; Kuznetsova, E. M.; Salimova, K. M. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 4, 410-13(1972). (In Russian).

Distribution coefficients for the extraction of rubidium and cesium salts by benzoyl acetone were determined. Both distribution coefficients and their ratio were shown to pass through a maximum as initial alkali concentration in aqueous solution increased. The possible explanation of the obtained results was given. (auth)

11736 SEPARATION OF Nb(V), Ti(IV), AND Mo(VI) BY CHROMATOGRAPHIC EXTRACTION IN THE SYSTEM TBP–HCl.

Alimarin, I. P.; Gibalo, I. M.; Lapenko, L. A. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 4, 435-8(1972). (In Russian).

The sorption of Nb(V), Ti(IV), and Mo(VI) in the system TBP–HCl on a chromatographic column was investigated. A method for the separation of the elements mentioned was developed, based on differences in their chromatographic behavior. (auth)

11737 RUBIDIUM AND CESIUM EXTRACTION BY HYDROXYQUINOLINE AND SALYCYL ALDEHYDE. Kuznetsova, E. M.; Magomedbekov, U. G.; Salimova, K. M. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 4, 477-9(1972). (In Russian).

Hydroxyquinoline and salycylaldehyde were studied as extractants for rubidium and cesium in the presence of sodium hydroxide. The distribution coefficients attained their maxima when extractant and alkali concentrations were equal. In case of salycylaldehyde and hydroxyquinoline the maximal β values were: $\beta_{Cs} = 0.95$, $\beta_{Rb} = 0.70$ and $\beta_{Cs} = 0.85$, $\beta_{Rb} = 0.85$ respectively. (auth)

11738 SEPARATION OF BERYLLIUM FROM TUNGSTEN AND MOLYBDENUM ON THE CARBONATE FORM OF ANION-EXCHANGER AB-17. Eristavi, V. D. Soobshch. Akad. Nauk. Gruz. SSR; 68: No. 3, 585-8(Dec 1972). (In Russian).

A method is proposed for the separation of beryllium from tungsten and molybdenum on the CO_3 form of anion-exchanger AB-17 column-diameter 1.6 cm, height of swollen sorbent layer 15 cm. As a result of consecutive elution of 1N and 5N by means of $(NH_4)_2CO_3$ or of 1N by means of $(NH_4)_2CO_3$ and 3N by means of NaOH the first eluate contains tungsten and molybdenum and the second beryllium. The relative error of the determination of beryllium after its separation from tungsten and molybdenum does not exceed ±8%. (auth)

11739 SOLVENT EXTRACTION OF ACTINIDE AND LANTHANIDE ELEMENTS BY QUATERNARY AMMONIUM SALTS. PART II. EXTRACTION OF U, Np, AND Pu BY CETYLPYRIDINUM BROMIDE AND NITRATE FROM SOLUTIONS OF NITRIC AND HYDROCHLORIC ACIDS. Szeglowski, Z.; Gavrilov, K. A.; Kim, Y. B.; Om, S. I.; Mikulski, J. (Joint Inst. for Nuclear Research, Dubna, USSR). Nukleonika; 17: No. 7-8, 383-8(1972). (In Russian).

Conditions are described for extraction of U, Np, and Pu by means of solutions of cetylpyridinium salts in chloroform containing isoamyl alcohol. The distribution coefficients of Pu(IV) were observed to decrease linearly with an increase in the concentration of isoamyl alcohol. It was also found that the extraction process of Pu(IV) depended on the character of the anion cetylpyridinium salt. The solvation number was determined for Pu(IV) and Pu(VI) in solutions of nitric and hydrochloric acids. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 12442, 13967, and 13968.

11740 CATALYTIC RECOMBINATION FOR OXYGEN AND HYDROGEN IN OFF-GAS OF NUCLEAR POWER PLANTS. Mizuno, A.; Tani, J. (Osaka Oxygen Industries Ltd.). Koatsu Gasu; 9: No. 2, 486-92(Apr 1972). (In Japanese).

A series of experiments were performed to obtain design data for the catalytic recombinator of oxygen and hydrogen in the off-gas from nuclear power plants. Objective, method, and result of the experiments are described. 0.5 wt % palladium–alumina spherical catalyzer of diameter 3.2 ~ 6.4 mm was used as sample. The recombination experiment was performed with the vol % of oxygen ranging from 0.65 to 2.2 and that of hydrogen from 1.1 to 4.0. As a result of the recombination, remainder of the hydrogen was below 1 ppm in all cases. Temperature of the catalyzer, on the other hand, rose to 190 to 490°C, depending on the initial content of the oxygen and hydrogen. Mechanical strength and activity of the catalyzer were also tested under various conditions. The results show that performance of the catalyzer does not worsen if the temperature is kept below 500°C. (Japan)

Chemical and Physicochemical Properties

Refer also to abstracts 11679, 11852, 12386, 12485, 13000, 13001, and 13973.

11741 (CEA-R-4333) STUDY OF CONCENTRATED METAL-AMMONIA SOLUTIONS: MAGNETIC PROPERTIES AND NON METAL–METAL TRANSITION. Lelieur, J.-P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1972. 142p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis submitted to Paris Univ., Orsay (France).

The magnetic susceptibility of alkali metal–liquid ammonia solutions was measured in the concentration range where the solutions show a progressive passage toward the metallic state. The Knight shift of the metal nuclei and the nitrogen nucleus were determined as a function of concentration and temperature, in Na–NH_3 and Cs–NH_3 solutions. A phenomenological analysis of the transport properties of metal–ammonia solutions is also presented. This analysis permits the presentation of a model for the mechanism of the transition to the metallic state. (auth)

11742 (CEA-R-4347) STUDY OF POLYANIONS SUBSTITUTED BY Zr OR OTHER ELEMENTS OF THE SAME GROUP. Fauris, Christine (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1972. 113p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

Anomalies observed during the processing of fission products involving the use of mixed phosphotungstate-phosphate ion exchangers led to the hypothesis that complexes are formed between W (or Mo), P, and Zr. Investigations were subsequently carried out (in solution) involving the partial replacement of W (or Mo) in the corresponding hetero-polyanion structures by Zr(IV). Compounds of this type, substituted by various elements, were recently discovered and studied. Some of the research was conducted envisaging a central atom other than phosphorus (Si, Ge) and tetravalent substituting elements other than Zr. The existence of a certain number of compounds between Zr(IV) and iso- or heteropolymolybdates (or tungstates) was established by previously having complexed them with ligands, the role of which is to buffer the solution and avoid precipitation of the Zr. The composition and stability of the mixed compounds, thus formed, were studied for Zr(IV) and neighboring elements, in order to establish similarities between such elements and those of different valencies (V in particular). The substitutional facility of Mo (or W) by Zr (and neighboring elements) was compared with different central atoms. This facility is most enhanced with phosphorus compounds. Derivatives in the 2–18 series can be easily obtained, not only for phosphorus, but also for silicon and germanium, while for the nonsubstituted derivatives, this series, either does not exist (Si, Ge), or forms under very special conditions (P). (auth)

11743 (CEA-R-4392) ELECTROCHEMICAL STUDY OF THE PROPERTIES OF MAGNESIUM CHLORIDE IN MOLTEN LiCl AND KCl AND IN THE LiCl–KCl EUTECTIC. Le Vaguerese, Sylvain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1972. 67p. (In French). Dep. NTIS (U. S. Sales Only).

The properties of magnesium chloride solutions in molten chlorides were studied because of the use of these chlorides in various pyrochemical processes for treatment of nuclear fuels. This electrochemical study revealed the presence of OH ions in the LiCl and LiCl–KCl molten solvents. These ions are associated in complex forms with the solvent. Potentiometric studies show that magnesium chloride in LiCl–KCl solution is associated with chloride ions. The values of the energy of activation for diffusion confirm the presence of this complex ion and point out the part played by the structure of the solvent in diffusion. Reaction electrodes were studied by chronoamperometry with continuously varying potentials. The chlorine electrode was used as a reference, especially for potentiometric studies. (auth)

11744 (CONF-701074-12) PROSPECTS OF THE USE OF COMPLEXONES IN NUCLEAR POWER ENGINEERING. Margulova, T. Kh.; Rassokhin, N. G.; Tevlin, S. A.; Bogatyreva, S. V.; Bursuk, L. M. Translated from pp 52-68 of Proceedings of the Scientific and Technical Conference on Atomic Power, Fuel Cycles, and the Radiation Study of Materials, Ul'yanovsk, USSR, 5–10 October 1970, Vol. II. 13p. Dep. NTIS.

The application of complexones for pre-start and operational cleaning of the secondary and primary circuits, to increase corrosion resistance and hydrogen absorption resistance of perlite steels, and for constant correction of the water conditions of secondary and primary circuits is discussed. (MCG)

11745 (COO-1140-205) HIGH TEMPERATURE CHEMISTRY. Progress Report, November 1, 1971–October 31, 1972. Gilles, P. W. (Kansas Univ., Lawrence. Dept. of Chemistry). 1972. Contract AT(11-1)-1140. 21p. Dep. NTIS.

The education of graduate students and postdoctoral research associates in fields of interest to AEC is described. Lists of publications on the research work are included. Research studies on vaporization of titanium oxides reveal that the composition of the congruently vaporizing Ti_3O_5 solution is O/Ti = 1.70 ± 0.02 and that the range of homogeneity is O/Ti = 0.04 ± 0.01. The degree of fragmentation of TiO_2^+ is less than five percent. Mass spectrometric studies are designed to interrelate absolute vapor pressure measurements through isomolecular exchange reactions. Ion species and neutral molecules were identified and partly charac-

terized in the complicated vaporizing ternary V-W-O system. The kinetics of vaporization of cuprous chloride were studied by vacuum balance and mass spectrometric techniques. The vaporization coefficients for several species were measured and have been tentatively interpreted in terms of a vaporization model. A data acquisition and equipment control system was used effectively. (auth)

11746 PREPARATION AND CHARACTERISATION OF THE COMPOUNDS Na_4TiO_4 AND Na_2ZrO_3. Barker, M. G.; Wood, D. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., Dalton Trans.; No. 22, 2448-50(1972).

Three preparations of the compounds Na_4TiO_4 and Na_2ZrO_3 are described and their formulae confirmed by thermogravimetric analysis. The x-ray diffraction pattern of Na_4TiO_4 is indexed as orthorhombic with cell dimensions a = 11.607, b = 13.610, and c = 9.693 Å, and the compound appears to be one member of an isostructural series of compounds. (auth)

11747 NEW METHOD FOR DETERMINATION OF QUANTUM YIELDS BY COMBINED USE OF THIN-LAYER CHROMATOGRAPHY AND RADIOISOTOPES. Duerr, H.; Herbst, P.; Rozumek, K. E. (Univ. of des Saarlandes, Saarbruecken, Ger.). J. Chromatogr.; 73: No. 1, 287-9(8 Nov 1972). (In German).

11748 MIXED THIOLSULFONATES AND SULFONAMIDES FROM POLYFUNCTIONAL MERCAPTANS USING TRIFLUOROMETHYL THIOSULFONATES. Weidner, J. P.; Block, S. S. (Univ. of Florida, Gainesville). J. Med. Chem.; 15: No. 5, 564-7(May 1972).

Methods of preparing compounds to be tested as radioprotectants and bactericides are presented. The compounds prepared fall into three groups: asymmetrical thiosulfonates from cysteine and related structures; sulfonamides from mercaptopurines and similar compounds; and asymmetrical disulfides. It was found that thiosulfonate derived from penicillamine and trifluoromethyl methanethiosulfonate was effective in protecting both bacteria and mice even though the concentration at which it had to be used, limited to toxicity, was necessarily quite low. (DHM)

11749 I. SOLUTION AND STRUCTURAL STUDIES OF TERTIARY PHOSPHINE AND ARSINE COMPLEXES OF COPPER(I) HALIDES. II. THE CRYSTAL STRUCTURE OF URANIUM BOROHYDRIDE. Mayerle, J. J. New York; Columbia Univ. (1972). 158p. University Microfilms Order No. 72-28,066.

Thesis.

I. Equilibria occurring in chloroform solutions containing tertiary phosphine and arsine complexes of the type $[(C_6H_5)_{3-n}(CH_3)_nY]_mCuX$ (n = 0, 1, 2; m = 3, 2, 1.5; Y = P, As; X = Cl, Br, I) were investigated using vapor pressure osmometry. The effects of the substituents on the group V donor atom, the group V donor atom itself, and the choice of the halide on the extent of ligand dissociation of the 3 : 1 compounds L_3CuX are presented and discussed. The most striking influence is shown to be a stereochemical one, exemplified by the relative stabilities of the L_3CuCl complexes, L = $(C_6H_5)_3P \ll (C_6H_5)_2(CH_3)P \simeq (C_6H_5)(CH_3)_2P$. The arsine complexes are more highly dissociated than their phosphine analogs. The system $(C_6H_5)_3P/Cu$-Br is discussed in detail, and the predominant complex in solutions having $(C_6H_5)_3P$: CuBr ratios of 3 : 2 is shown to be the ligand-deficient dimer $[(C_6H_5)_3P]_3Cu_2Br_2$. Tables of ^1H (methyl) temperature and concentration dependent NMR results for $[(C_6H_5)_2(CH_3)P]_3CuCl$ and $[(C_6H_5)(CH_3)_2P]_3CuCl$ are given. The NMR results show that ligand dissociation increases with decreasing temperature for the 3 : 1 phosphine complexes. The syntheses of several new complexes of the type $[(C_6H_5)_{3-n}(CH_3)_nY]_mCuX$ (n = 1,2; Y = As, P; m = 2,3; X = Cl, Br, I) are described. The crystal structure of di-μ-chlorotetrakis(dimethylphenylarsine)dicopper(I) is reported. The compound crystallizes as colorless octahedra in space group $P2_1/c$. The structure was refined to final values of the discrepancy indices of $R_1 = 0.059$ and $R_2 = 0.076$. The structure consists of centrosymmetric chloride-bridged dimeric molecules of $\{[(C_6H_5)(CH_3)_2As]_2CuCl\}_2$. The coordination geometry about the copper atom shows significant deviations from tetrahedral symmetry. The important bond distances and angles are Cu–As: 2.350(2) Å, 2.368(2) Å; Cu–Cl: 2.375(4) Å, 2.385(4) Å; Cl–Cl: 3.672(2) Å, As–Cu–As: 117.98(9)°; As–Cu–Cl: 105.3(1)°, 100.7(1)°, 115.0(1)°, 115.1(1)°; Cl–Cu–Cl: 100.6(1)°; and Cu–Cl–Cu: 79.0(1)°. II. From x-ray diffraction, uranium borohydride crystallizes in the tetragonal space group $P4_32_12$ ($P4_12_12$) with unit cell dimensions a = b = 7.49(1) Å and c = 13.24(1) Å. There are four units of $U(BH_4)_4$ per unit cell. From 493 independent reflections collected by diffractometer, the uranium and boron positions were determined and refined by least-squares techniques to final values for the discrepancy indices of $R_1 = 0.040$ and $R_2 = 0.048$. Refinement in the enantiomorphic space group $P4_12_12$ yielded final values of R_1 and R_2 of 0.041 and 0.050, respectively. Parameters reported are those for $P4_32_12$. The structure is polymeric, consisting of interlocking helical chains. There are six tetrahydroborate groups associated with each uranium atom, four of which are bridging and two of which are terminal. The bridging borohydride groups are approximately equally spaced between two uranium atoms with a mean U–B distance of 2.87(3) Å. The terminal borohydride groups, in a cis-configuration to each other, are at a distance of 2.54(3) Å from the uranium atom. A short summary of a neutron diffraction study of this compound is included. (Diss. Abstr. Int., B)

Isotope Effects

11750 ISOTOPE EFFECT IN THE GLUCOSE OXIDASE REACTION AS DETERMINED BY ION-EXCHANGE CHROMATOGRAPHY. Marshall, L. M.; Appiah, Augustine Howard Univ., Washington, DC). J. Chromatogr.; 73: No. 1, 257-61(8 Nov 1972).

^{14}C isotope effects in enzymatic reactions involving carbon-I of a sugar were investigated. Results supported a positional isotope effect in early times of incubation and seemed to rule out the possibility that a radiochemical impurity could account for the data. (M.C.G.)

11751 SPECTROSCOPIC STUDIES ON MATRIX-ISOLATED METAL CARBONYLS. Pt. 1. USE OF $C^{18}O$ ENRICHMENT TO OBTAIN CHARACTERISTIC FREQUENCY AND INTENSITY PATTERNS. Darling, J. H.; Ogden, J. S. (Oxford Univ.). J. Chem. Soc., Dalton Trans.; No. 22, 2496-2503(1972).

A description is given of a general method of characterising simple binary carbonyls produced under matrix isolation conditions, where ir spectroscopy is often the only means of detection. Ir band frequency and intensity patterns are calculated for a number of isotopically mixed carbonyls, and in particular, it is shown that if a mixture of $C^{16}O$ and $C^{18}O$ were used in the metal-atom synthesis of these compounds, then the species MCO, $M(CO)_2$, $M(CO)_3(D_{3h})$, $M(CO)_4(D_{4h}$ or $T_d)$, and $M(CO)_6(O_h)$ would each give rise to a characteristic frequency and intensity pattern. These patterns not only reveal the stoicheiometry and symmetry of the species, but also yield the appropriate Cotton-Kraihanzel force constants. The calculations are displayed as line spectra and cover a wide range of force constants. (auth)

11752 DEUTERIUM ISOTOPE EFFECT IN THE ENZYMATIC TRANSAMINATION OF L-DEUTERIO-PHENYLALANINE TO DEUTERIO-PHENYLPYRUVIC ACID. Kluza, R. B. Chicago; Univ. of Illinois (1971). 180p. University Microfilms Order No. 72-30,168.

Thesis.

The ionic fraction obtained from the cell wall hydrolysate of Scenedesmus obliquus grown in culture medium containing 99.6 percent deuterium oxide was subjected to ion-exchange column chromatography to effect the fractionation of L-deuterio-phenylalanine. Gradient elution techniques employing HCl (1N to 4N) were utilized in the fractionation. L-Deuterioleucine was isolated and identified, concurrently. Enzymatic transamination employing rat brain extract was studied for the protio and deuterio analogues of L-phenylalanine. The basic reaction mixture contained the respective amino acid analogue, alpha-ketoglutarate, pyridoxal-5-phosphate, the rat brain extract, and 0.4 M phosphate buffer. The phenylpyruvate formed during transamination was determined by an arsenate-catalyzed enol-borate assay procedure, spectrophotometrically, at 300 nm. For each amino acid analog, the rate of transamination was determined in media containing varying concentrations of the amino acid and alpha-ketoglutarate. Kinetic determination of maximum velocity, based on the binary mechanism of enzymatic transamination, was conducted by graphical analyses of the experimental data. Least squares regression analysis was performed on the resultant data to obtain best-fit straight lines. A primary deuterium isotope effect was observed and was expressed as V_H/V_D, the ratio of the maximum velocity of L-protiophenylalanine to that of L-deuteriophenylalanine. The deuterated amino acid exhibited an isotope effect of 1.64. The maximum velocity of the transamination of the deuterated substrate was decreased by 39% when compared with the maximum velocity of the protio analogue. (Diss. Abstr. Int., B)

11753 SECONDARY DEUTERIUM ISOTOPE EFFECT ON LEWIS BASICITY: TRIS(DIPIVALOYLMETHANATO)-EUROPIUM AS A SIMPLE AND EFFECTIVE PROBE. Sanders, J. K. M.; Williams, D. H. (Cambridge Univ., Eng.). J. Chem. Soc., Chem. Commun.; No. 8, 436-7(19 Apr 1972).

Investigation of equilibrium isotope effects via competition experiments with the paramagnetic shift reagent $Eu(dpm)_3$ is described and it is shown that in the aliphatic alcohols studied deuterium is effectively more electropositive than protium; the method may be extended to other substituents. (auth)

11754 DISPROPORTIONATION OF HOD IN CONDENSED PHASES. Van Hook, W. A. (Univ. of Tennessee, Knoxville). J. Chem. Soc., Chem. Commun.; No. 8, 479-80(19 Apr 1972).

The law of the geometric mean for the vapour pressure isotope effect in the series HOH, HOD, and DOD is not obeyed; rather in $[P(H_2O)/P(D_2O)]/\ln[P(H_2O)/P(HOD)] = 1.91 \pm 0.03$, so the equilibrium constant for the reaction HOH + DOD = 2 HOD, K_I (condensed), is significantly larger than K_I (dilute gas); the difference varies from 1.5 ± 0.5% at −25°C to 0.3 ± 0.1% at 75°C. (auth)

11755 MECHANISM OF THE BENZIDINE REARRANGEMENT. II. THE REARRANGEMENT OF N-ACETYLHYDRAZOBENZENE. Cox, J. R. Jr.; Dunn, M. F. (Georgia Inst. of Tech., Atlanta). J. Org. Chem.; 37: No. 26, 4415-21(29 Dec 1972).

In concentrated perchloric acid–sodium perchlorate solutions, N-acetylhydrazobenzene undergoes an intramolecular rearrangement to N-acetylbenzidine. The rate of rearrangement has a first-order dependency on the Hammett acidity, H_0, and is subject to a small solvent isotope effect, $k_{H_2O}/k_{D_2O} = 1.27$. A small but reproducible substrate isotope effect is observed on the rate of rearrangement of the ring perdeuterated material, $k_H/k_D = 1.07$. On the basis of these observations it is concluded that the rearrangement is clearly a manifestation of the benzidine rearrangement, that the mechanism of rearrangement involves a single proton transfer in an equilibrium established prior to the rate-limiting process, and that both the solvent deuterium isotope effect and the substrate deuterium isotope are secondary isotope effects. Arguments are given in favor of a pathway involving a rate-limiting heterolysis of the nitrogen–nitrogen σ bond following the preequilibrium proton transfer. The electron-withdrawing, inductive effect of the N-acetyl substituent is envisaged to usurp the catalytic role of the second proton in the acid-catalyzed rearrangement of hydrazobenzene. The driving force for bond heterolysis and rearrangement is a cumulation of the repulsion between the N-acetyl group and the protonated N′-amino nitrogen, and incipient bonding of a π-complex type. The reaction of N-acetylhydrazobenzene to give benzidine (and presumably diphenyline) in dilute acid solutions probably proceeds via slow hydrolysis to hydrazobenzene, followed by rapid rearrangement to the observed products. (auth)

11756 VISCOSITY OF THE ISOTOPES OF HYDROGEN AND THEIR INTERMOLECULAR FORCE POTENTIALS. Kestin, J.; Ro, S. T.; Wakeham, W. A. (Brown Univ., Providence). J. Chem. Soc., Faraday Trans., I; 68: No. 12, 2316-23(1972).

Improved, absolute measurements of the viscosity of the three isotopes of hydrogen at 22, 25 and 28°C as well as of the three resulting viscosity ratios are described. The ratios have been determined by a direct calculation and with an uncertainty of ±0.09%. The results are consistent with the hypothesis that the three species interact with slightly different intermolecular force potentials. The order of magnitude of these differences is estimated following Diller and Mason (J. Chem. Phys.; 44: 2604 (1966)). (auth)

11757 MEASUREMENT OF SOLVENT ISOTOPE EFFECTS WITH CATION SELECTIVE GLASS ELECTRODES. Lowe, B. M.; Smith, D. G. (Univ. of Edinburgh). J. Chem. Soc., Chem. Commun.; No. 17, 989-90(6 Sep 1972).

Cation selective glass electrodes can be used to measure the free energy of transfer of an ionic solute from H_2O to D_2O; the value obtained for sodium chloride is 709 ± 39 J mol^{-1}. (auth)

11758 VIBRATIONAL ASSIGNMENT AND FORCE CONSTANTS OF HALOGENOMETHYLSILANES AND THEIR GERMANIUM ANALOGUES: $ClCH_2SiH_3$, $ClCH_2SiD_3$, $BrCH_2SiH_3$, $BrCH_2SiD_3$, $ClCH_2GeH_3$, AND $ClCH_2GeD_3$. Ohno, K.; Murata, H. (Hiroshima Univ.). Bull. Chem. Soc. Jap.; 45: No. 11, 3333-42(Nov 1972).

The infrared spectra of $ClCH_2SiH_3$, $ClCH_2SiD_3$, $BrCH_2SiH_3$, $BrCH_2SiD_3$, $ClCH_2GeH_3$, and $ClCH_2GeD_3$ for both the gaseous and solid states in the 250 to 4000 cm^{-1} region were obtained. All the fundamental vibrations except for the skeletal bending and $YH_3(-D_3)$ (Y = Si, Ge) torsional vibrations were observed and assigned. The normal vibration calculation was carried out using a modified Urey–Bradley force field. The transferability of the force constants was also investigated. (auth)

11759 INFRARED SPECTRUM OF THE WATER–HYDROCHLORIC ACID COMPLEX IN SOLID NITROGEN. Ault, B. S.; Pimentel, G. C. (Univ. of California, Berkeley). J. Phys. Chem.; 77: No. 1, 57-61(4 Jan 1973).

The infrared spectrum was recorded of the 1:1 complex of HCl and H_2O (and the deuterated counterparts) isolated in a nitrogen matrix at 15°K. The $H_2O \cdot HCl$ complex absorbs at 2638, 2540, and 460 cm^{-1}, whereas $D_2O \cdot DCl$ absorbs at 1916, 1849, and 330 cm^{-1}. The spectra of the mixed isotopic species show that the hydrogen atoms are not equivalent. This fact, and a comparison to the spectra of prototype compounds, show that the complex does not involve hydronium ion, but, rather, a simple hydrogen bond, $H_2O \cdots H-Cl$, in which the HCl hydrogen atom remains attached to the chlorine atom. This result can be rationalized with thermodynamic considerations about the stability of an isolated $H_3O^+ \cdot Cl^-$ ion pair. (auth)

11760 HYDROPHOBIC INTERACTION IN LIGHT AND HEAVY WATER. Ben-Naim, A.; Wilf, J.; Yaacobi, M. (Hebrew Univ., Jerusalem). J. Phys. Chem.; 77: No. 1, 95-102(4 Jan 1973).

The solubility, free energy, entropy, and enthalpy of solution of methane, ethane, n-butane, benzene, and biphenyl were determined in light and heavy water. The hydrophobic interaction between the pairs methane–methane, ethane–ethane, and benzene–benzene was computed in these two liquids. It was found that the strength of the hydrophobic interaction for the first two pairs is larger in H_2O than in D_2O. The order seems to be reversed for the pair benzene–benzene. (auth)

11761 ISOTOPE EFFECT IN THE DECOMPOSITION OF AMMONIA ON TUNGSTEN SURFACES. Dawson, P. T.; Peng, Y. K. (McMaster Univ., Hamilton, Ont.). J. Phys. Chem.; 77: No. 1, 135-6(4 Jan 1973).

Issue is taken with a suggestion by Sheets and Blyholder [J. Phys. Chem. 76, 970 (1972)] that the observed isotope effect in the decomposition of ammonia on tungsten surfaces could be understood as β-secondary isotope effect, allowing nitrogen desorption to be rate limiting. The basis for this conclusion is that the surface contains no hydrogen. Recent studies have identified a hydrogen-containing η species during the catalytic decomposition of ammonia on tungsten surfaces. There is still considerable speculation as to the nature of the isotope effect. Nevertheless, its magnitude suggests that it is a primary isotope effect. (D.H.M.)

11762 ENAMINE FORMATION AND HYDROLYSIS. ETHYL β-CYANOMETHYLAMINOCROTONATE. Guthrie, J. P.; Jordan, Frank (Harvard Univ., Cambridge, MA). J. Amer. Chem. Soc.; 94: No. 26, 9132-6(27 Dec 1972).

Rate constants for the hydrolysis of the enamine ethyl β-cyanomethylaminocrotonate (1) in H_2O and D_2O were studied as a function of pH and buffer concentration. At high buffer concentration, from pH 4 to pH 7, the rate-determining step is the acid-catalyzed addition of water to the imine tautomer. At very low buffer concentrations, tautomerization is rate determining. Equilibrium constants were measured as a function of pH, so that rate constants for enamine formation may be calculated. The equilibrium constant for the formation of 1 from free aminoacetonitrile and ethyl acetoacetate is 0.94 M^{-1}. (auth)

Isotope Exchange and Isotope Separation

11763 FRACTIONATION OF TRITIATED WATER IN POTASSIUM CHROMIUM SULFATE DODECAHYDRATE. Tanaka, H.; Kado, T.; Negita, H. (Hiroshima Univ.). Bull. Chem. Soc. Jap.; 45: No. 11, 3342-5(Nov 1972).

A considerable dilution of tritiated water in the water of crystallization was observed in the crystal-growth process of $KCr(SO_4)_2 \cdot 12H_2O$ from a slightly supersaturated aqueous solution. This was explained in terms of an ionic process in aqueous solution and a surface-diffusion mechanism of crystal growth. It was also found that the tritium content in the hexahydrate was appreciably smaller than that in the liberated water during the course of reaction; $KCr(SO_4)_2 \cdot 12H_2O \xrightarrow[\text{in vacuo}]{40°C} KCr(SO_4)_2 \cdot 6H_2O + 6H_2O$. It seems that the stepwise dehydration supports the dehydration mechanism proposed by Garner. (auth)

11764 REACTION OF LEAD TETRAACETATE WITH UNSYMMETRICAL KETONES. Moon, Sung; Bohm, Howard (Adelphi Univ., Garden City, NY). J. Org. Chem.; 37: No. 26, 4338-40(29 Dec 1972).

2-Butanone, when treated with lead tetraacetate (LTA) in acetic acid, gave 1-acetoxy-2-butanone as the major product. Similarly, 3-methyl-2-butanone and 2-octanone gave 1-acetoxy-3-methyl-2-butanone and 1-acetoxy-2-octanone as the major products. Phenylacetone, however, gave 1-acetoxy-1-phenyl-2-propanone as the major product. Similar results were obtained in propionic acid, propionoxy ketones being the major products, although minor amounts of acetoxy ketones were obtained. In trifluoroacetic acid, trifluoroacetoxy ketones were obtained, and the major products were 3-trifluoroacetoxy-3-methyl-2-butanone, 3-trifluoroacetoxy-2-octanone, and 1-trifluoroacetoxy-2-propanone. Deuterium exchange results indicate that the rates of substitution for the less and the more highly substituted positions for 2-octanone and isopropyl methyl ketone are about equal, while the rates of substitution for the more highly substituted position is favored in 2-butanone and phenylacetone. Enol acetates, when treated with LTA, yield acetoxy ketones, and the position of the acetoxyl group

is dependent upon the position of the double bond in the parent enol acetate. (auth)

11765 ISOTOPIC TRITIUM EXCHANGE EQUILIBRIUM OVER A PLATINUM CATALYST IN A HYDROGEN–CYCLOHEXANE SYSTEM. Isagulyants, G. V.; Klimov, A. P.; Khairudinov, I. R. (Inst. of Organic Chemistry, Moscow). Kinet. Katal.; 13: No. 4, 1079-81(1972). (In Russian).

The coefficient of isotopic separation of tritium was determined in a static hydrogen–cyclohexane system over the temperature range 178 to 243°C. The experiments were conducted with tritium-labeled cyclohexane and with hydrogen containing tritium, so as to approach equilibrium from either side. The thermal effect of the exchange reaction was determined from the temperature dependence. (tr-auth)

11766 EXTRINSIC MAGNETIC FIELD EFFECT ON PARA-HYDROGEN AND ORTHODEUTERIUM CONVERSION CATALYSED BY NEODYMIUM OXIDE. Eley, D. D.; Forrest, H.; Pearce, D. R.; Rudham, R. (Univ. of Nottingham, Eng.). J. Chem. Soc., Chem. Commun.; No. 21, 1176-7(8 Nov 1972).

A magnetic field of 2.1 kOe increases the rate of parahydrogen conversion, but decreases the rate of orthodeuterium conversion at 10^3 N m^{-2} on Nd_2O_3 at 273 and 540 K; since the effect with para-hydrogen was only observed when Nd_2O_3 was outgassed at 673 K, it appears to be sensitive to the extent of surface dehydration. (auth)

11767 FLAME STRUCTURE AND FLAME REACTION KINETICS. VII. REACTIONS OF TRACES OF HEAVY WATER, DEUTERIUM, AND CARBON DIOXIDE ADDED TO RICH HYDROGEN + NITROGEN + OXYGEN FLAMES. Dixon-Lewis, G. (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A; 330: No. 1581, 219-45(3 Oct 1972).

The overall reactions of traces of heavy water, deuterium, and carbon dioxide added to some fuel-rich hydrogen + nitrogen + oxygen flames were examined both experimentally and theoretically. The mechanism and most of the controlling rate constants for the flames both without and with the additives are now sufficiently firmly established for computation of the detailed flame profiles to be possible in all cases. By comparison of the computed profiles with experiment it is possible to deduce information about the reactions: $OH + H_2 \rightarrow H_2O + H$, $OH + HD \rightarrow HOD + H$, and $OH + CO \rightarrow CO_2 + H$. At 1050°K the ratios $k_1/k_{1Da} = 2.8$ and $k_1/k_{21} = 11.3$ were found, both with an accuracy of ±15%. Assuming $A_1/A_{1Da} = 2.4$ (the ratio of collision frequencies) led to a mean $k_1/k_{1Da} = 2.4 \exp(+155/T)$; while combination of the observed ratio k_1/k_{21} with results of other investigators led to $k_1/k_{21} = (120 \pm 15) \exp\{-(2400 \pm 50)/T\}$. It was also possible to relate the absolute rate constants for the above reactions fairly precisely with the hydrogen atom recombination rate constant k_{15}, so that for a known value of the latter, the former could be derived with an accuracy of ±10 to 15%. For $k_{15} = 4.5 \times 10^{15}$ for all molecules, the values found for the three rate constants were $k_1 = (2.7 \pm 0.4) \times 10^{12}$, $k_{1Da} = (9.6 \pm 0.5) \times 10^{11}$ and $k_{21} = (2.4 \pm 0.12) \times 10^{11}$, all at 1050°K. Combination of the observed values of k_1 and k_{21} at 1050°K with those of other investigators led to the expressions $\lg k_1 = 13.57 \pm 0.15 - (2770 \pm 100)/2.303T$, $\lg k_{21} = 11.49 \pm 0.15 - (370 \pm 100)/2.303T$. (auth)

11768 NEW SERIES OF HOMOGENEOUS METAL CATALYSTS FOR VERY RAPID HYDROGEN ISOTOPE EXCHANGE IN AROMATIC COMPOUNDS. Garnett, J. L.; Long, M. A.; Vining, R. F. W.; Mole, T. (Univ. of New South Wales, Kensington, Australia). J. Chem. Soc., Dhem. Commun.; No. 21, 1172-3 (8 Nov 1972).

A range of metal halides catalyse, within a few minutes at room temperature, complete exchange of the aromatic hydrogen atoms between two molecules such as perdeuteriobenzene and toluene, this exchange not being subject to the steric effects and side reactions of the much slower conventional Pt catalysed deuterium labelling procedures. (auth)

11769 SEPARATION OF CLOSE SPECIES BY DISPLACEMENT DEVELOPMENT ON ION EXCHANGERS. I. A THEORETICAL EQUATION OF STEADY-STATE PERMUTATION FRONT. EXPERIMENTAL VERIFICATION IN THE CASE OF THE SEPARATION OF BORON ISOTOPES. Conrard, Patrick; Caude, Marcel; Rosset, Robert (CNRS, Paris). Separ. Sci.; 7: No. 5, 465-86(1972).

The chromatographic plate theory was applied to the displacement development on ion exchangers of a band containing a mixture of two very closely related species. When the number of plates of the band P is small and the separation factor $\alpha = 1 + \epsilon$ is close to unity so that $P\epsilon \ll 1$, and if one of the species of the mixture is of a small percentage, then a linear distribution of the concentrations in the band is obtained. In a more general case the distribution's equation is given. The band is symmetrical only if its initial composition is 50-50. In every other case the plate corresponding to the initial mixture is not the median plate of the band. A mathematical expression was derived, which gives the place of the median in the band. A practical determination of the distribution of species in a steady-state band, when P, ϵ, and the composition of the mixture are known, is given. A limited experimental verification is given for the case of the separation of boron isotopes. (auth)

11770 COMPARISON OF THEORETICAL STEADY-STATE ISOTOPIC DISTRIBUTION AND OF AN EXPERIMENTAL PROFILE IN THE CASE OF SEPARATION OF NITROGEN ISOTOPES ON ION-EXCHANGE COLUMNS. Conrard, Patrick; Rosset, Robert (CNRS, Paris). Separ. Sci.; 7: No. 5, 487-90(1972).

In displacement development of a mixture of very closely related species on ion exchange columns, determination of the distance between the band middle and the point of initial composition permits an evaluation of HETP. This was applied to the work of Spedding et al., on the separation of nitrogen isotopes. It is shown that steady-state distribution was not obtained and that classical equation giving displacement length for steady-state conditions does not apply for very closely related species such as isotopes. (auth)

11771 GAS CHROMATOGRAPHY-MASS SPECTROMETRY OF BIOSYNTHETIC ^1H–^2H HYBRID FATTY ACID METHYL ESTERS. Oldfield, E. (Univ. of Sheffield, Eng.). J. Chem. Soc., Chem. Commun.; No. 12, 719-20(21 Jun 1972).

Deuterium-enriched lipids were isolated from the plasma membranes of the organism Acholeplasma laidlawii B(PG9) grown on media supplemented with 97 at. % deuteriated lauric acid. Gas chromatography and mass spectroscopy of lipid derived methyl esters are interpreted as indicating chain elongation of the deuteriated lauric acid by 1 or 2 protonated C_2-units. (auth)

11772 NATURE OF THE $\alpha\beta$-PROCESS IN PALLADIUM-CATALYSED MULTIPLE EXCHANGE REACTIONS OF POLYCYCLIC HYDROCARBONS WITH DEUTERIUM: SIGNIFICANCE OF BRIDGEHEAD OLEFIN STABILITY. McKervey, M. A.; Rooney, J. J.; Samman, N. G. (Queen's Univ., Belfast). J. Chem. Soc., Chem. Commun.; No. 21, 1185 (8 Nov 1972).

The ease with which multiple exchange reactions of polycyclic hydrocarbons with deuterium, catalyzed by palladium, propagate through bridgehead positions is related to the stability of the appropriate bridgehead olefin, indicating that the $\alpha\beta$ process in exchange involves interconversion of a σ-bonded metal alkyl and a π-bonded metal alkene. (auth)

11773 CHEMISTRY OF SMALL RING COMPOUNDS. 14. ACIDITY OF CYCLOPROPANES WITH ELECTRON-WITHDRAWING SUBSTITUENTS. van Wijnen, W. Th.; Steinberg, H.; de Boer, Th. J. (Univ., Amsterdam). Tetrahedron; 28: No. 21, 5423-32(Nov 1972).

The hydrogen isotope exchange rates of α-deuterio- and α-tritiocyclopropanes with electron-withdrawing substituents and the corresponding open 2-substituted propanes were measured in solutions of sodium methoxide in methanol. Substituents fall in two classes: CF_3, CN, and ϕSO_2 make the α-hydrogen in cyclopropanes more acidic than in the open chain analogues. On the other hand acyl groups (t-C_4H_9CO, iso-C_3H_7CO, C_6H_5CO) make the cyclopropanes less acidic than the corresponding 2-substituted propanes. An explanation based on inductive and mesomeric stabilization of carbanions is given. A large isotope effect has been found for bulky isopropyl t-butyl ketone, suggesting rate limiting hydrogen abstraction by base. In most other cases isotope effects are small, presumably because anions remain strongly associated with methanol by hydrogen bonding (e.g., R^- ... $DOCH_3$) and consequently solvent exchange (with MeOH) becomes rate limiting for D/H(T/H) exchange. (auth)

11774 CALCULATION OF H/D, $^{12}C/^{13}C$, AND $^{12}C/^{14}C$ FRACTIONATION FACTORS FROM VALENCE FORCE FIELDS DERIVED FOR A SERIES OF SIMPLE ORGANIC MOLECULES. Hartshorn, S. R.; Shiner, V. J. Jr. (Indiana Univ., Bloomington). J. Amer. Chem. Soc.; 94: No. 26, 9002-12(27 Dec 1972).

The computer programs of Schachtschneider and Snyder were used to fit force fields to published, observed fundamental frequencies of vibration for a series of small organic molecules and their deuterated analogs. These force fields were used to calculate H/D, $^{12}C/^{13}C$, and $^{12}C/^{14}C$ fractionation factors for specific positions in each molecule. The fractionation factors of H attached to carbon are affected in a regular way by variations in the nature of the other groups attached to the same carbon but within the accuracy of the calculations do not seem to be significantly affected by the nature of substituents one atom further removed. Similarly the carbon fractionation factors are affected by the nature of the atoms directly attached but are hardly influenced by more remote structural changes. The use of these factors in

the interpretation of equilibrium and kinetic isotope effects is illustrated for several reactions. (auth)

11775 ACTIVATION OF AROMATIC CARBON–HYDROGEN BONDS BY TRANSITION METAL COMPLEXES. II. SUBSTITUTED BENZENES. Klabunde, U.; Parshall, G. W. (E. I. du Pont de Nemours and Co., Wilmington, DE). J. Amer. Chem. Soc.; 94: No. 26, 9081-7(27 Dec 1972).

Competitive exchange between D_2 and aromatics is catalyzed by polyhydride transition metal complexes. The relative rates of exchange of mono- and disubstituted benzenes increase in the order $p\text{-}(CH_3)_2 < CH_3 \sim OCH_3 < H < CF_3 \sim F < p\text{-}F_2$ for the $NbH_3(C_5H_5)_2$, $[NbH(C_5H_5)(\mu\text{-}C_5H_4)]_2$, and $IrH_5[(CH_3)_3P]_2$ catalyzed reactions. Except for p-xylene, only slight differences in rates were observed with $TaH_3(C_5H_5)_2$ and $TaH_3(C_5H_4CH_3)_2$. Differences in rates of the various positions were observed with the largest effect due to steric hindrance by the substituents. A mechanism involving a series of alternating reductive–elimination and oxidative–addition steps is proposed. (auth)

11776 HIGHLY-EFFECTIVE METHOD FOR THE SEPARATION OF ACTINIDE ISOTOPES. Beyer, G. J.; Herrmann, E.; Molnar, F.; Raiko, V. I.; Tyrroff, H. (Joint Inst. for Nuclear Research, Dubna, USSR). Radiochem. Radioanal. Lett.; 12: No. 4-5, 259-269(20 Dec 1972).

The efficiency of a surface ionization ion source for the electromagnetic separation of some actinide elements was determined. The efficiency was found to depend on the source temperature and separation time. The following efficiencies were obtained: for actinium 80%, thorium 5.2%, uranium 9%, plutonium 51%, curium 72%, and californium 37.5%. The chemical charge preparation is described. (auth)

11777 ISOTOPIC EFFECTS IN RECOMBINATION AND CONVERSION OF IONS. Panchenkov, G. M.; Basov, Yu. G.; Utirov, B. U. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 4, 400-4(1972). (In Russian).

The formulas for calculation of the isotopic separation coefficient in the processes of recombination by binary and ternary collisions and in the processes of conversion of atomic ions to molecular ones were derived. (auth)

11778 METHOD FOR THE STUDY OF PLATINUM SURFACE IN THE REACTION OF HYDROGEN ISOTOPE EXCHANGE. Mitrofanova, A. N.; Nikitin, O. T.; Boronin, V. S.; Poltorak, O. M. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 4, 383-8(1972). (In Russian).

The exchange of deuterium adsorbed on Pt/SiO_2 with gaseous hydrogen was studied in the temperature range 77 to 293°K. The average size of the platinum particles varied from 10 Å up to 50 Å. The degree of platinum dispersion was evaluated by chemisorption of hydrogen. On the basis of the results obtained the conclusion was derived that the surface of platinum was not uniform in this reaction, and this phenomenon was not defined by structural factors, and it was not connected with the presence of impurities on the surface of catalyst. (auth)

Feed Materials Processing

Refer also to abstract 11889.

11779 (DOCKET-406622-5) SHIRLEY BASIN URANIUM MINE, Supplemental Environmental Information. (Utah International, Inc., San Francisco, Calif.). 12 Jan 1973. 20p. Dep. NTIS.

Information is presented to provide detailed descriptions of a number of processes and project changes made or planned for the Shirley Basin Uranium Mill and how these changes might alter the environmental impact of the mill operation. Topics discussed include the tailings dam, increase in mill tonnage, surge pond for water recycling, filter installation, dryer installation, sand slime separation of solids, tailing solution return, and uranium precipitants. (MCG)

Radiation Chemistry

Refer also to abstracts 11711, 13838, and 13843.

11780 (COO-2217-2) INVESTIGATION OF MOLECULAR MECHANISMS IN PHOTODYNAMIC ACTION AND RADIOBIOLOGY WITH NANOSECOND FLASH PHOTOLYSIS AND PULSE RADIOLYSIS. Progress Report, April 1, 1972–March 31, 1973. Grossweiner, L. I. (Illinois Inst. of Tech., Chicago). 1972. Contract AT(11-1)-2217. 13p. Dep. NTIS.

A laser flash photolysis apparatus has been constructed providing outputs of 200 millijoules at 530 nm and 20 millijoules at 265 nm in single 20 nanosecond pulses. The time resolution for transient species absorbing from 220 to 800 nm is 5 nanoseconds for spectrophotometric detection and 10 microseconds with a photographic plate spectrograph. The apparatus is being employed to study the photodynamic and ultraviolet inactivation of enzymes. The pulse radiolysis technique is being used to investigate the radiolytic cleavage of thymine dimer generated by ultraviolet irradiation of thymine. It has been found that the dimer is cleaved efficiently by hydrated electrons, subsequent to the formation of a short-lived intermediate attributed to the dimer electron adduct. The irradiation of thymine dimer in the presence of glucose also induces cleavage. This process is highly selective and has not been observed with alcohols, sucrose, and radical anions including I_2^-, CO_3^-, CO_2^-, and $(CNS)_2^-$. These studies are being extended to dimers generated in oligonucleotides and polynucleotides. (auth)

11781 (IS-T-539) RADIOLYSIS OF TRIS(ETHYLENEDIAMINE) COBALT(III) SALTS. Witiak, David (Ames Lab., Iowa). Dec 1972. Contract W-7405-eng-82. 93p. Dep. NTIS. Thesis.

The effects of radiation on the optically active coordination compounds $[CO(en)_3]X_3$ (where $X = Cl^-$, Br^-, I^-, and NO_3^-) were studied in the solid state. Thermal racemization, x- and gamma-induced effects as well as the crystal structure of the nitrate salt were studied. The rate of loss of optical activity was in the order $I^- > Br^- > Cl^- > NO_3^-$ for the various forms of radiation. The activation energy, for thermal racemization, of the nitrate salt was about four times larger than for the various halide salts. This was attributed to the greater number of possible hydrogen bonds between the oxygens of the nitrate group and the amine hydrogens. A compound with elemental composition $C_2H_6N_2$ was observed after the x-ray bombardment of $[CO(en)_3](NO_3)_3$. Identification of the exact geometry of the compound has not been solved. The crystal structure of $D\text{-}[Co(en)_3](NO_3)_3$ was determined using three-dimensional single-crystal x-ray techniques. The compound crystallized in the orthorhombic space group $P2_12_12_1$. The lattice constants were a = 14.570, b = 12.607, and c = 8.756 Å, with four formula units in the unit cell. Atoms of Co, N, C, and O were refined anisotropically. The derived structure was refined by least-squares methods to an unweighted R index of 8.4%. The coordination about the cobalt atom was essentially octahedral with an average Co–N distance of 1.974 ± 0.008 A. (auth)

11782 (ORO-2001-28) RADIATION INDUCED EFFECTS IN ORGANIC SYSTEMS. Progress Report, December 1, 1971–December 15, 1972. Johnsen, R. H. (Florida State Univ., Tallahassee). 1972. Contract AT(40-1)-2001. 121p. Dep. NTIS.

AMINO ACIDS— spectra of radicals in, ESR
CATIONS— neutralization of organic, in collisions with stainless steel surfaces
CRYSTALS— radiolysis of liquid, radical recombination kinetics in γ
ELECTRONS— effects on thin organic films at 77°K
FREE RADICALS— reactions of radiolytic, in liquid crystals
GAMMA RADIATION— effects on liquid crystals
HYDROGEN— reactions of atomic, in organic matrices, infrared heating in
— diffusion of radiolytic molecular, in organic solids
METHYL RADICALS— reactions of ionized, in methane, charge exchange cross section for
NITROGEN OXIDES NO— reactions of NO^+, with rare gases, charge exchange cross sections for
ORGANIC COMPOUNDS— radiation chemistry of
— radiation effects on thin films of, at 77°K, electron
— radiolysis of solid, diffusion of hydrogen in
OXYGEN IONS (O_2^+)— reactions with rare gases, charge exchange cross sections for
RARE GASES— reactions with nitric oxide ions, charge exchange cross sections for
— reactions with molecular oxygen ions O_2^+, charge exchange cross sections for (M.C.G.)

11783 NANOSECOND KINETIC STUDY OF THE ROTATIONAL TEMPERATURE DECAY OF THE $CH(A^2\Delta \rightarrow X^2\pi)$, EMISSION PRODUCED BY PULSE RADIOLYSIS OF CH_4 AND C_2H_2. Clerc, M.; Schmidt, M. (CEN de Saclay, Gif-sur-Yvette, France). Discuss. Faraday Soc.; No. 53, 217-29(1972).

A 10^{-9}s pulse radiolysis study of the discrete rotational levels of the $CH(A^2\Delta - X^2\pi)$ emission gives the kinetics of the rotational temperature decay of $CH(A^2\Delta)$ during fluorescence; variations of the rate for rotational de-excitation of the discrete levels are determined for ten rotational levels of the (0-0) band. The $CH(A^2\Delta)$ radical is produced initially from CH_4, with 0.07 eV and from C_2H_2 with 0.6 eV rotational energy. The electronic radiative lifetime has been measured for 3 rotational bands: the values vary from 480 to 575 ns. (auth)

11784 SYNTHESIS AND RADIOLYSIS OF ANHYDROUS $ThCl_4$, $ThBr_4$, AND ThI_4. Carlier, R. (Inst. of Radium, Paris); Genet, M. Rev. Chim. Miner.; 9: No. 4, 625-32 (1972). (In French).

A method of preparing anhydrous tetrahalides is described. Owing to the very hydroscopic nature of these salts their synthesis and purification is carried out under vacuum or in an atmosphere containing less than 10×10^{-6} parts of water vapor. The quantity of radiolytic halogens formed in the tetrahalide by irradiation with γ radiation from ^{60}Co was measured. (France)

11785 POLNOE SOBRANIE NAUCHNYKH TRUDOV V SHESTI TOMAKH. TOM V. RADIATSIONNAYA KHIMIYA I DOZIMETRIYA IONIZIRUYUSHCHIKH IZLUCHENII. (Complete Collection of Scientific Proceedings in Six Volumes. Volume 5. Radiation Chemistry and Dosimetry of Ionizing Radiations). Starodubtsev, S. V. Tashkent; Izdatel'stvo Fan Uzbekskoi SSR (1972). 436p.

The first five chapters of this work consist of 62 papers by S. V. Starodubtsev and collaborators on the topics: radiation changes in liquid organic systems and solutions, the effect of gamma radiation, neutrons, and high-voltage discharges on reactions in gaseous systems, the radiolysis of solid bodies in a field of ionizing radiation, the spectrometry of neutron fluxes from a reactor, and radiation effects on the surfaces of solid bodies. The sixth chapter is a small monograph (112 pages) by S. V. Starodubtsev and Sh. A. Ablyaev whose subject is radiation effects on gel surfaces. This subject is divided into three sections: photoabsorption, gamma-absorption, and cathode-absorption effects. (K.S.W.)

11786 ESR STUDY OF IRRADIATED TBP–DODECANE–HNO_3 SYSTEMS. Nowak, Z.; Nowak, M.; Michalik, J.; Owczarczyk, A. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 12: No. 2-3, 78-88(29 Nov 1972).

The systems TBP–HNO_3 and TBP (30 vol.%)–n-dodecane were irradiated together with 0.5, 1, 3, 4, 5, and 8M nitric acid in a ^{60}Co source at ambient temperature and examined by ESR techniques. The presence of stable radicals could be detected. In systems irradiated with a dose 50 Wh/l the highest spin concentration was observed for the TBP–dodecane system irradiated together with 1M nitric acid. A similar dependence was obtained from the plot of Z-number against HNO_3 concentration. Radicals formed at low HNO_3 concentrations appear also as a result of post-irradiation effects and their concentration increases after removing the sample from the irradiation position. Post-irradiation effects were also observed in the studies of Z-number. (auth)

11787 EFFECTS OF WATER VAPOR AND THE CHARGE DISTRIBUTION IN GAMMA IRRADIATED POLY(METHYLMETHACRYLATE). Connolly, F. J. Lawrence, KS; Univ. of Kansas (1972). 220p. University Microfilms Order No. 72-32,872.

Thesis.

Changes in the electrical properties of poly(methyl methacrylate) (PMMA) after irradiation by ^{60}Co γ rays were studied. The role of water in the PMMA samples on the observed thermally stimulated currents and associated integrated charges was investigated. The effects of varying the temperature gradient, the heating rate, the radiation dose, and the sample size on the thermally stimulated currents of irradiated PMMA for annealed samples were also investigated. The role of water in poly(methyl methacrylate) was observed to have a critical effect on the qualitative nature of the thermally stimulated currents in the γ-irradiated polymer. There were also significant differences in the quantitative results both in current magnitude and integrated charge. Polymer specimens containing water exhibited only one current peak of positive polarity, but dried samples caused the current profiles to shift in magnitude and polarity resulting in two positive peaks separated by a negative peak. The positive current occurring at relatively low temperatures (from 30 to 80°C) was attributed to a water polarization mechanism, while the subsequent negative and positive peaks were postulated to be due to charge recombination between different charged species that vary in concentration, mobility and stability. The thermally stimulated currents observed in isotropically irradiated PMMA were not necessarily thermoelectric in nature, but were dependent upon the existence of a temperature gradient for the generation of a displacement current in the external measuring circuit. The integrated charge of the current profiles was most probably independent of the heating rate. (TSS) (Diss. Abstr.)

11788 ISOLATION, CHARACTERIZATION, AND γ-IRRADIATION OF α-CRYSTALLINES FROM BOVINE, CANINE, AND OVINE LENSES. Ferguson, W. E. Galveston, TX; Univ. of Texas (1972). 84p. University Microfilms Order No. 72-29,571.

Thesis.

α-Crystallins were isolated from the ocular lenses of the bovine, canine, and ovine by chemical and chromatographic means. The isolated α-crystallins were subjected to increasing γ-irradiation dosages (0.25×10^5 to 2.5×10^6 Rads) in the lyophilized state and in solution at 2 and 4% protein concentrations. Irradiation of lyophilized native α-crystallins caused extensive loss of solubility. Remaining soluble protein exhibited fragmentation, increased aggregation upon sedimentation analysis, and initial decrease in intrinsic viscosity followed by increases when irradiated in the dry state. α-Crystallin solutions irradiated at 4% protein concentrations exhibited increased fragmentation, aggregation by sedimentation analysis, and increased intrinsic viscosities. α-Crystallins irradiated in solution at 2% protein concentrations showed increased production of the 3S fragment, increased aggregation as revealed by sedimentation analysis and increased intrinsic viscosities. Canine α-crystallin was the most susceptible to irradiation in the dry state and in solutions at 4% protein concentration. Bovine α-crystallin showed less damage than canine but more than ovine. In 2% solutions, bovine α-crystallin showed the greatest effects of irradiation with canine being affected to a lesser degree and ovine showing the least amount of damage. Alkaline-modified bovine α-crystallin which was already altered showed little change with increasing irradiation dosage. No electrophoretic changes were observed in the α-crystallins upon irradiation. The bovine, canine, and ovine α-crystallins were 2 to 3 times more susceptible to irradiation than were bovine fibrinogen and serum albumin. (Diss. Abstr. Int., B)

11789 SOVREMENNYE PROBLEMY RADIOBIOLOGII. TOM III. MOLEKULYARNAYA RADIOBIOLOGIYA. (Contemporary Problems in Radiobiology. Vol. III. Molecular Radiobiology). Strazhevskoi, H. B. Moscow; Atomizdat (1972). 264p.

The six chapters comprising this book were prepared by different authors. The role of radiolysis products of water in the transformation of aqueous solutions of biopolymers and the radiolysis of dilute aqueous solutions of monosaccharides and their derivatives are examined. Luminescence was employed to study the radiation effects on proteins. Radiation damage to DNA is discussed in two chapters, and radiation damage to cell membranes is the topic of the concluding chapter. (797 references) (K.S.W.)

11790 ROLE OF SURFACE INTERACTIONS ON THE PROPERTIES OF γ-IRRADIATED POLYDIMETHYL-SILOXANE–SILICA COMPOSITES. Brender, H. Montreal; McGill Univ. (1972). National Library of Canada, Ottawa.

Thesis.

An investigation was made into the nature of the increase in the apparent degree of cross-linking, the restriction of swelling, and the changes in tensile modulus which occur when silica is incorporated into polydimethylsiloxane. Two different particle size silicas, untreated and coated with chemisorbed trimethylsilyl groups, were used. The properties of the composites are interpreted in terms of the physical and chemical interactions between silica and polydimethylsiloxane. The increase in network chain densities of the composites due to silica is shown to be very much greater than the number of network chains due to polymer-filler chemical bonds. As a result the composites were examined in the light of the Kraus swelling theory. From this study it was possible to speculate on the thickness of the layer of polymer bound to the surface of a filler particle and to derive a detailed swelling equation, taking into account the "expanded reinforcement volume." The tensile modulus data was then related to the expanded reinforcement volume. (Diss. Abstr.)

11791 EFFECT OF SOLVENT ON THE REACTIVITY OF THE ELECTRON. Teply, J.; Janovsky, I. (Inst. of Nuclear Research, Rez, Czech.). Chem. Phys. Lett.; 17: No. 3, 373-6(1 Dec 1972).

Rate constants of reactions of solvated electrons with various compounds in liquid 2-methyltetrahydrofuran relative to the rate of the reaction with N_2O were determined and compared with analogous data for other solvents. From present considerations and comparisons it may be inferred that neither Hammett correlation of rate constants with substituent constants σ nor the correlation with electron absorption coefficients in gas phase characterizes the nature of the reactivity of these compounds towards the electron in solution. (auth)

11792 OPTICAL ABSORPTION SPECTROSCOPY OF ThO_2. Childs, B. G.; Harvey, P. J.; Hallett, J. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Amer. Ceram. Soc.; 55: No. 11, 544-7(Nov 1972).

Optical absorption spectra from 200 to 2700 nm were determined for arc-fused ThO_2 crystals of much higher purity than any available hitherto. The fundamental absorption edge for these crystals lies at a much higher energy (≈5.9 eV) than the apparent edge reported previously for less pure specimens. This apparent edge is shown to result from one or more prominent high-energy absorption bands superimposed on the true edge for such specimens. By comparing the spectra for different specimens subjected

to thermal and γ-irradiation treatments, 31 distinct absorption bands were revealed in the ThO_2 spectrum. A full analysis of certain crystals by spark-source mass spectrometry gave no strong correlation between specific band areas and individual impurity-element concentrations. Most of the bands, however, are believed to be associated with the impurity content. (auth)

11793 ELECTRON SPIN RESONANCE STUDIES OF THE CARBON DIOXIDE ANION RADICAL ADSORBED ON X-TYPE ZEOLITES. Sogabe, K.; Hasegawa, A.; Yamada, Y.; Miura, M. (Hiroshima Univ.). Bull. Chem. Soc. Jap.; 45: No. 11, 3362-6(Nov 1972).

The hindered motion and the structure of the CO_2^- radical adsorbed on various zeolites were investigated by means of ESR spectroscopy. The adsorbed CO_2^- radical was obtained by the γ-irradiation of zeolites with carbon dioxide labeled with ^{13}C. The results show that the interaction of the CO_2^- radical with the zeolite surface changes with the electrostatic field on the surface. The motion and the structure of the adsorbed CO_2^- radical are affected by the properties of the zeolite surfaces; the former is also influenced by the extent of exchange of the cation on zeolite, regardless of the time of irradiation, before or after the introduction of carbon dioxide. The formation of the CO_2^- radical on zeolites was interpreted on the basis of such a mechanism that electrons are initially trapped by the surface of zeolite upon the irradiation and then transferred to carbon dioxide molecules. The results also show that the process of the electron transfer depends on the kind of cation. (auth)

11794 ELECTRON SPIN RESONANCE EVIDENCE FOR THE FORMATION OF N_2O^- FROM NITROUS OXIDE BY γ-RADIATION. Mishra, S. P.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Chem. Commun.; No. 9, 510-11(10 May 1972).

Carbon disulphide solutions of nitrous oxide at 77°K after exposure to ^{60}Co γ-rays showed ESR spectra of a species containing two dissimilar nitrogen atoms thought to be N_2O^-. (auth)

11795 STABILITY OF N_2O^- IN CYCLOHEXANE. Dainton, F. S.; O'Neill, P.; Salmon, G. A. (Univ. of Leeds, Eng.). J. Chem. Soc., Chem. Commun.; No. 17, 1001-2(6 Sep 1972).

Pulse-radiolysis studies show that N_2O^- formed in cyclohexane solution can transfer an electron rapidly to galvinoxyl (GAL), a property shared by the anions of O_2, SF_6, CO_2, and CH_3NO_2 but not by those of I_2, CCl_4, and $C_2(CN)_4$; N_2O^- is estimated to have a lifetime in cyclohexane not less than 20 μs. (auth)

11796 ELECTRON SPIN–LATTICE RELAXATION IN MOLECULAR CRYSTALS: S = ½. Dalton, L. R. (Harvard Univ., Cambridge, Mass.); Kwiram, A. L.; Cowen, J. A. Chem. Phys. Lett.; 17: No. 4, 495-9(15 Dec 1972).

Results of an extensive investigation of electron relaxation in radiation-damaged organic materials are presented. The recovery of electron magnetization following pulsed saturation is determined (a) by Heisenberg exchange or molecular reorientation-induced spectral diffusion (cross relaxation) and (b) by the spin–lattice relaxation (SLR) processes characteristic of the material examined. Spectral diffusion quenching procedures were employed to minimize the effects of (a), thus permitting measurement of SLR times. Local mode effects, torsional oscillations and/or exchange interactions between radicals, as well as direct and Raman spin–phonon processes contribute to the observed temperature dependence of the SLR times for the approximately twenty radical systems studied. The frequently observed quadratic temperature dependence of the SLR rates is particularly noteworthy. Two mechanisms that give rise to such behavior have been explored theoretically and are discussed briefly. (auth)

11797 ABSORPTION SPECTRUM OF THE HYDRATED ELECTRON AT HIGH PRESSURES: CALCULATION OF THE PRESSURE SHIFT OF THE ABSORPTION PEAK. Nilsson, G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Chem. Phys. Lett.; 17: No. 4, 539-42(15 Dec 1972).

The structure of excess electron localization center in water was identified with the structure of the dodecahedral cavities in hexagonal ice. Based on this model the pressure shift of the optical absorption peak, the oscillator strength, and the photoconductivity threshold energy of the excess electron were calculated. (auth)

11798 TRAPPED ELECTRONS IN ETHYLENE GLYCOL/WATER GLASS. PHOTO-INDUCED CONDUCTIVITY AND RECOMBINATION LUMINESCENCE. Moan, J. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Chem. Phys. Lett.; 17: No. 4, 565-8(15 Dec 1972).

The optical excitation of trapped electrons, e_t^-, in EG/H_2O glass was studied by photoconductivity and recombination luminescence measurements. The quantum efficiency of the producing photocurrent shows a steep increase with excitation energy from about 2.2 eV. A similar wavelength dependence was found for the quantum efficiency of stimulating recombination between trapped electrons and tryptophan ions in photoionized samples of tryptophan in EG/H_2O. Since e_t^- in EG/H_2O glass absorbs energy quanta down to 1.7 eV it was concluded that the lowest excited states of e_t^- in EG/H_2O are bound ones. The quantum efficiency of stimulating recombination luminescence decreases with increasing temperature, indicating that the retrapping of mobilized electrons becomes more efficient. This demonstrates that molecular reorientation is important in electron trapping in the present matrix. (auth)

11799 ENDOR STUDIES OF X-IRRADIATED NAPHTHALENE SINGLE CRYSTALS. Boehme, U. R.; Wolf, H. C. (Univ., Stuttgart). Chem. Phys. Lett.; 17: No. 4, 582-7(15 Dec 1972).

Detailed ENDOR studies in the α-hydronaphthyl radical led to the determination of spin density distribution, hyperfine principal axes, and values of the dipole–dipole interaction of all CH and CH_2 protons in the radical. Mirror image α-hydronaphthyl radicals show different concentrations because of a different crystal surrounding of chemically equivalent CH_2 groups. (auth)

11800 MOBILITY OF EXCESS ELECTRONS IN LIQUID METHANE. Schmidt, W. F.; Bakale, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Chem. Phys. Lett.; 17: No. 4, 617-19 (15 Dec 1972).

The drift velocity of excess electrons in liquid methane was measured for electric fields from 75 to 15,000 V cm^{-1}. At lower field strengths the drift velocity increases proportional to the electric field and yields a mobility of (450 ± 50) $cm^2\ V^{-1}\ sec^{-1}$. Above 1500 V cm^{-1} the drift velocity varies with $E^{½}$. (auth)

11801 POLYMERIZATION OF VINYL KETONES. Lyons, A. R. (Thames Polytechnic, London). J. Polym. Sci., Part D; 6: 251-93(1972).

Free-radical initiation, ionic initiation, and free-radical copolymerization are discussed. Irradiation and degradation of poly(vinyl ketones) are also considered. (116 references). (M.C.G.)

11802 REDUCTION WITH TRICHLOROSILANE. IV. ETHER FROM ACETAL. Nakao, Ren; Fukumoto, Tsugio; Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture, Sakai, Japan). J. Org. Chem.; 37: No. 26, 4349-52(29 Dec 1972).

The reduction of acetals derived from formaldehyde, acetaldehyde, acetone, and diethyl ketone to the corresponding ethers with trichlorosilane under γ irradiation was studied. An acetal reacts at first with chlorosilane to give an α-chloroether, which is in turn reduced with the silicon hydride under γ irradiation. The reduction of mixed acetal containing a triethylsilyl group makes clear the reduction sequence of an ester through an acetal type intermediate. (auth)

11803 ELECTRON-TRANSFER REACTIONS OF COBALT(III) AND RUTHERNIUM(III) AMMINES WITH EUROPIUM(II), YTTERBIUM(II), AND SAMARIUM(II) IN AQUEOUS SOLUTIONS. Faraggi, M.; Feder, A. (Nuclear Research Centre-Negev, Beer-Sheva, Israel). Inorg. Chem.; 12: No. 1, 236-41(Jan 1973).

Kinetic measurements, using the pulse radiolysis technique, were made on the reaction of Sm(II), Yb(II), and Eu(II) with pentaammine complexes of Co(III) and Ru(III). The order of reactivity is Sm(II) > Yb(II) > Eu(II). This order is correlated with the electrode potential E° of the divalent ions. The resulting reactivity patterns were examined with the view of providing a possible kinetic basis for distinguishing between inner- and outer-sphere electron-transfer mechanisms. The reactions of the three divalent lanthanide ions with the hexaammine- and the ethylenediaminecobalt(III) complexes were too slow to be followed by this technique. With the exception of a possible significant contribution of an outer-sphere mechanism to the reduction of the cobalt(III) aquo complex with Sm(II), the reactions of the three Ln(II) ions with the other cobalt pentaamine complexes take place predominantly by an inner-sphere mechanism. Reactivities of corresponding Ru(III) and Co(III) complexes are compared. The electron-exchange rate constants for the Ln(II)–Ln(III) couples were calculated using Marcus' theory of electron-transfer reactions. (auth)

11804 ABSORPTION SPECTRA OF INTERMEDIATES FORMED DURING RADIOLYSIS AND PHOTOLYSIS. PART II. Habersbergerova, A.; Janovsky, I.; Kourim, P. (Nuclear Research Inst., Rez, Czech). Radiat. Res. Rev.; 4: No. 2-3, 123-231(Oct 1972).

The literature from 1967 until the end of 1970 is covered and data from the liquid and solid phases are involved. The tables give data for hydrated electrons, trapped electrons, solvated electrons, inorganic free radicals and unstable ions, and organic free radicals and positive and negative ions. (410 references). (M.C.G.)

11805 HALOGEN ATOM CHARGE-TRANSFER COMPLEXES. Buehler, R. E. (Swiss Federal Inst. of Tech., Zurich). Radiat. Res. Rev.; 4: No. 2-3, 233-58(Oct 1972).

Available data on halogen atom charge transfer complexes is reviewed. Most of the discussion is based on the unique CT ab-

sorption band located in the uv or visible region. Comparison revealed that some assignments should be reconsidered. Theoretically derived characteristics of halogen atom charge transfer complexes are discussed. (62 references). (M.C.G.)

11806 THEORY OF SOLVATED ELECTRONS. Webster, B. C.; Howat, G. (Univ. of Glasgow). Radiat. Res. Rev.; 4: No. 2-3, 259-300(Oct 1972).

Observations and theory of electrons in water, ammonia, and organic solvents are discussed. The five areas of observations suggested as a minimum requisite for a theory of solvated electrons to be viable are: primary processes, dilation measurements, absorption spectral phenomena, induced electron migration, and ESR spectra. Pekar and Ogg theories are described and semicontinum models are discussed. Consideration of the interactions solely at a molecular level is also suggested. (81 references). (M.C.G.)

11807 E. P. R. STUDY OF γ-IRRADIATED SINGLE CRYSTALS OF $K_2C_2O_4 \cdot H_2O$ AND $(NH_4)_2C_2O_4 \cdot H_2O$. Krishnamurthy, M. V. (Bhabha Atomic Research Centre, Bombay). Mol. Phys.; 24: No. 6, 1353-9(Dec 1972).

The electron paramagnetic resonance of γ-irradiated single crystals of $K_2C_2O_4 \cdot H_2O$ and $(NH_4)_2C_2O_4 \cdot H_2O$ was studied. The spectra show interesting microwave power saturation effects. The singlet spectrum is attributed to the $C_2O_4^-$ radical derived from the $C_2O_4^{2-}$ ion. The principal g-values are determined to be 1.998, 2.0028, and 2.0004. Certain weak lines are observed with different power saturation and interpreted as due to OH radicals derived from water molecules in the crystal lattice. (auth)

11808 E. P. R. OF TRAPPED H ATOMS IN γ-IRRADIATED ACIDIC GLASSES. CROSS RELAXATION INDUCED BY Cu(II) ORGANIC COMPLEXES. Thind, K. S.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). Mol. Phys.; 24: No. 6, 1249-55(Dec 1972).

Cross relaxation induced by Cu(II) organic complexes was observed, and the relative rates measured, for the trapped H atoms in γ-irradiated aqueous acidic glasses. Significant superhyperfine structure was also observed on both the $g_\perp$ and $g_\parallel$ components of the EPR of Cu(II) complexes in the acidic glasses. Evidence is presented that such super hyperfine structure is due to axial interactions between the planar Cu(II) complexes and the water molecules or the H_3O^+ ions. (auth)

11809 UNSTABLE INTERMEDIATES. Pt. 121. ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED HEXAMETHYLPHOSPHORAMIDE: ON THE NATURE OF SOLVATED ELECTRONS. Rao, K. V. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 12, 2081-6(1972).

The ESR spectrum of γ-irradiated hexamethylphosphoramide (HMPA) at 77°K comprised an outer doublet, assigned to $(Me_2N)_2\dot{P}O$ radicals, and an inner triplet assigned to $H_2\dot{C}N(Me)PO(NMe_2)$ radicals. On partial annealing, a second doublet appeared which is also assigned to the latter radicals. Those radicals responsible for the central features are thought to have the phosphorus atom close to the radical plane, with strong π-conjugation to nitrogen, whilst those showing a large hyperfine coupling to phosphorus are thought to have a conformation in which overlap with the N-P σ-orbital is at a maximum. The latter radicals may well be N-protonated. The significance of these results with respect to metal-HMPA solutions and the nature of "solvated" electrons in this medium is outlined. (auth)

11810 ELECTRON–ELECTRON DOUBLE RESONANCE OF IRRADIATED DICHLOROFLUOROACETAMIDE: THE DOMINANT ROLE OF THE CHLORINE QUADRUPOLE. Kispert, L. D.; Chang, K.; Bogan, C. M. (Univ. of Alabama, University). Chem. Phys. Lett.; 17: No. 4, 592-7(15 Dec 1972).

Electron–electron double resonance (ELDOR) investigations of the $\cdot CClFCONH_2$ radical in irradiated single crystals of dichlorofluoroacetamide at −100°C were carried out. ELDOR spectra taken in a direction perpendicular to the radical plane show two intense lines at $A(^{35}Cl)$ and $\frac{3}{2}A(^{35}Cl) - \nu_{Cl}$ in addition to other weaker lines. Preliminary measurements of chlorinated radicals indicated that simple and intense ELDOR patterns can be observed below −50°C, with decreasing ELDOR intensity above −50°C as a result of the dominant quadrupole relaxation. (auth)

11811 YIELDS OF EXCITED STATES IN THE PULSE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS. Dainton, Frederick; Ledger, M. B.; May, R.; Salmon, G. A. (Cookridge Hospital, Leeds, Eng.). J. Phys. Chem.; 77: No. 1, 45-9(4 Jan 1973).

The yields of excited singlet states formed on the electron irradiation of cyclohexane solution of a series of naphthalene and anthracene derivatives and also of a number of miscellaneous scintillators were determined by a method which involves a comparison of the yields of radiation and light stimulated fluorescence from the solutions. Determinations were also of the triplet–triplet extinction coefficient of the naphthalene derivatives and also for anthracene and 9-bromoanthracene. Estimates are thus obtained for the ratios of the yield of initial triplet excited states formed to the yield of excited singlet states for these compounds, i.e., $G(T)_i : G(S)$. For the naphthalene derivatives $G(T)_i : G(S) \simeq 1.0$ and for anthracene and 9-bromoanthracene $G(T)_i : G(S) \simeq 1.5$. The effect of excimer formation on G(S) has been illustrated for PPO and anthracene and the rate constants for excimer formation for these solutes were estimated to be $5.6 \pm 1.4 \times 10^9$ and $7.4 \pm 2.0 \times 10^9$ M^{-1} sec^{-1}, respectively. (auth)

11812 ION–MOLECULE REACTIONS IN MONOGERMANE. Northrop, J. K.; Lampe, F. W. (Pennsylvania State Univ., University Park). J. Phys. Chem.; 77: No. 1, 30-5(4 Jan 1973).

Ion–molecule reactions occurring in ionized monogermane were studied by high-pressure mass spectrometry at pressures up to 200 μ and rate constants for second- and third-order reactions of all primary ions were measured. As expected the reactions observed and the specific reaction rates are much more similar to those occurring in monosilane than to those occurring in methane. (auth)

11813 PHOTOINDUCED IONIC POLYMERIZATION. II. CATIONIC POLYMERIZATION OF α-METHYLSTYRENE IN THE PRESENCE OF TETRACYANOBENZENE. Irie, Masahiro; Tomimoto, Setsuko; Hayashi, Koichiro (Hokkaido Univ., Sapporo). J. Polym. Sci., Polym. Chem. Ed.; 10: No. 11, 3235-42(Nov 1972).

The dependence of the rate of polymerization on light intensity and the stereoregularity of the polymer was studied to elucidate the propagation and termination mechanisms of the photoinduced cationic polymerization of α-methylstyrene in the presence of tetracyanobenzene in methylene chloride. The rate of polymerization was proportional to the light intensity. The polymer is highly syndiotactic, and the stereoregularity is similar to that of polymers obtained by radioinduced cationic polymerization. The initiation mechanism was also studied by electron spin resonance, by which the anion radical of tetracyanobenzene formed from a photoexcited complex between α-methylstyrene and tetracyanobenzene was observed. The cation radical of α-methylstyrene, counterpart of the anion radical, is believed to initiate the polymerization. (auth)

11814 SOLVENT STRUCTURE DEPENDENCE OF THE OPTICAL EXCITATION ENERGY OF SOLVATED ELECTRONS. Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem.; 77: No. 1, 7-9(4 Jan 1973).

Interpretation of optical excitation energies of solvated electrons in liquids and solids requires consideration of the solvent structure and the polarizabilities of the solvating groups. The importance of solvent structure is illustrated through the use of the Kirkwood correlation factor g_K, which indicates the extent to which molecules align themselves with their neighbors to create short-range order. Values of E_{max}, the energy at the absorption maximum, for e^-_{solv} in water, alcohols, ethers, ammonia, and amines measured over wide ranges of temperature and pressure correlate approximately with $\epsilon d g_K^3 \alpha_p$ where ε and d are the dielectric constant and density of the liquid, respectively, and α_p is the polarizability of the polar group in the molecule. A more detailed treatment would consider the anisotropy of α_p. (auth)

11815 ELECTRON EJECTION AND ELECTRON CAPTURE BY PHENOLIC COMPOUNDS. Feitelson, J.; Hayon, E. (Pioneering Research Lab., Natick, MA). J. Phys. Chem.; 77: No. 1, 10-15(4 Jan 1973).

The flash photolysis of air-free aqueous solutions of p-cresol, p-hydroxyphenylpropionic acid, tyramine, and tyrosine was studied on illumination of their long-wavelength absorption bands. The photodissociation into phenoxyl radicals, solvated electrons, and hydrogen atoms was examined. Experiments in the presence of 2,4-hexadiene, a typical triplet quencher, showed that the photoelectron ejection of these phenolic compounds in aqueous solution at 25°C takes place from a long-lived excited state, probably the triplet excited states of these molecules. The transient absorption spectra, extinction coefficients, and decay kinetics of the phenoxyl radicals were determined. The reactivity of all four substances toward hydrated electrons was studied by pulse radiolysis. The reaction rate constants were found to be dependent on the state of protonation of the hydroxyl and the amino groups. The transient absorption spectra due to the reaction of e^-_{aq} and H atoms (produced by photolysis or radiolysis) with these phenolic compounds were observed, with $\lambda_{max} \sim 350$ nm. It is shown that e^-_{aq} and H atoms add predominantly to the phenol ring of the compounds examined. (auth)

11816 POLAROGRAPHIC AND OPTICAL ABSORPTION STUDIES OF RADICALS PRODUCED IN THE PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF ETHYLENE GLYCOL. Bansal, K. M.; Graetzel, M.; Henglein, A.; Janata, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Phys. Chem.; 77: No. 1, 16-19(4 Jan 1973).

Simultaneous optical absorption and polarographic current measurements were carried out to investigate the free radicals formed in the pulse irradiation of N_2O saturated 10^{-1} M ethylene glycol solutions. In the pH range from 3 to 7, only the 1,2-dihydroxyethyl radical could be observed. It disappears with $2k \pm 6.7 \times 10^8$ M^{-1} sec^{-1}. Below pH 3, the dehydration of this radical to yield the formylmethyl radical was observed. The equilibrium constant of the protonization of 1,2-dihydroxyethyl and the decay constant of the protonated radical were found to be 1.8×10^{-1} M (or pK = 0.74) and 8.6×10^5 sec^{-1}, respectively. The formylmethyl radical disappears with $2k = 9 \times 10^8$ M^{-1} sec^{-1}. In alkaline solutions, a rapid dehydration also occurs. The diffusion-controlled reaction $OH^- + OH-\dot{C}HCH_2OH \rightarrow H_2O + {}^-OCHCH_2OH$ and the rapid decay ${}^-OCHCH_2OH \rightarrow OH^- + OCHCH_2$ are postulated. The short time polarograms of 1,2-dihydroxyethyl and formylmethyl differ significantly. 1,2-Dihydroxyethyl is oxidized at the mercury electrode at potentials more positive than −1.0 V (vs saturated calomel electrode) and reduced at more negative potentials. Formylmethyl is oxidized beyond −0.1 V and reduced at potentials more negative than −0.3 V. The 1,2-dihydroxyethyl radical therefore is a much stronger reducing agent than the formylmethyl radical. (auth)

11817 MECHANISM OF DECAY OF ALKYL RADICALS IN IRRADIATED POLYETHYLENE ON EXPOSURE TO AIR AS STUDIED BY ELECTRON SPIN RESONANCE. Seguchi, Tadao; Tamura, Naoyuki (Japan Atomic Energy Research Inst., Takasaki). J. Phys. Chem.; 77: No. 1, 40-4(4 Jan 1973).

The mechanism of decay of alkyl radicals in the crystalline region of polyethylene was investigated. The decay of alkyl radicals is observed with various kinds of polyethylene by electron spin resonance. A close relation is found between the decay rate and the sizes of crystallites. It is suggested that the alkyl radicals trapped in the crystalline region migrate to the surfaces of crystallites through hydrogen abstraction and decay by reaction with oxygen at the surfaces. The kinetics of the radical decay is well explained by the diffusion theory assuming that the decay rate is controlled by the rate of radical migration in the crystallites. The diffusion constant of alkyl radicals is estimated to be 3.0×10^{-18} cm^2 at 20°C. It is shown that the migration of alkyl radicals occurs intermolecularly rather than intramolecularly and the activation energy of migration is 18 kcal/mol. (auth)

11818 HYDROGEN SULFIDE RADIOLYSIS SENSITIZED BY HELIUM AND CARBON DIOXIDE. Jezierska, K. (Univ. of Warsaw); Forys, M. Nukleonika; 17: No. 9, 451-7(1972).

The radiolysis of hydrogen sulfide sensitized by helium and carbon dioxide was investigated over a wide range of concentrations. The radiation yield of hydrogen was measured as a function of energy absorbed by helium or carbon dioxide. It was shown that $G^s(H_2)$ is constant in a H_2S-He mixture and falls off to zero at low concentrations of hydrogen sulfide in the H_2S-CO_2 system. The possible mechanisms of energy transfer in these systems is proposed, including charge and excitation transfer. (auth)

11819 ADSORPTION OF IODINE VAPOR ON γ ^{60}Co PHOTONS IRRADIATED SILICA GEL. Sugier, H. (Inst. Technical Radiology, Lodz, Poland); Ludomirska, I. Nukleonika; 17: No. 5-6, 277-82(1972). (In Polish).

The influence of irradiation of silica gel by ^{60}Co γ photons on its adsorptive properties for iodine vapor was studied. Under irradiation paramagnetic surface centers are formed. They are responsible for irreversible adsorption of iodine. Conclusions regarding the transport of carriers and energy generated by radiation current to the surface of silica gel grains were drawn. (auth)

11820 IR SPECTRA OF γ-IRRADIATED POTASSIUM IODIDE (KI) MONOCRYSTALS. Sugier, H.; Tilk, S. (Inst. Technical Radiology, Lodz, Poland). Nukleonika; 17: No. 5-6, 259-66(1972). (In Polish).

The ir analyses were carried out for monocrystals of potassium iodide irradiated with ^{60}Co γ-rays. Radioinduced absorption bands were observed at 770, 1130, and 1590 cm^{-1}, respectively. The band at 770 cm^{-1} was attributed to the iodates formed during irradiations. The other bands were not fully identified but are due to some surface species. The influences of dose absorbed in the sample, conditions of irradiation, and preparation of samples on the ir spectra were also investigated. (auth)

11821 INTERMEDIATES IN THE RADIOLYSIS OF BENZYL ALCOHOL AT 77°K. Mayer, J.; Kroh, J. (Technical Univ., Lodz, Poland). Nukleonika; 17: No. 5-6, 267-75(1972).

The nature and yield of paramagnetic species produced by γ-irradiation of benzyl alcohol at 77°K were studied by EPR and optical absorption techniques. The EPR spectrum of γ-irradiated benzyl alcohol was assigned to $C_6H_5\dot{C}HOH$, $C_6H_5\dot{C}H_2$ radicals, and probably $(C_6H_5CH_2OH)^-$ anion. Gamma-irradiated benzyl alcohol gives an optical absorption spectrum having the characteristic bands in the uv region, which are assigned to benzyl radicals. The influence of various scavengers on the EPR and uv absorption spectra of γ-irradiated benzyl alcohol were also investigated. (auth)

11822 ADSORPTION OF PARAFFIN HYDROCARBONS ON γ-IRRADIATED AND NONIRRADIATED CHROMIUM OXIDE. Slovetskaya, K. I.; Aiginin, F. N.; Rubinshtein, A. M. (Inst. of Organic Chemistry, Kazan). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 9, 1969-75 (Sep 1972). (In Russian).

The adsorption of C_2 to C_6 hydrocarbons by samples of Cr_2O_3 that contained Cr^{2+} ions was studied before and after irradiation with ^{60}Co gamma rays. At temperatures below 100°C adsorption was rapid and reversible. Above 100°C irreversible adsorption occurred together with some equilibrium adsorption; this behavior could be correlated with the presence of Cr^{2+} ions. An increase in adsorption of $n-C_6H_{14}$ after γ-irradiation of Cr_2O_3 was associated with the formation of additional quantities of Cr^{2+} through electron capture by Cr^{3+} ions. (KSW)

11823 RADIATION COPOLYMERIZATION OF VINYL FLUORIDE WITH METHYL AND BUTYL ACRYLATES. Usmanov, Kh. U.; Yul'chibaev, A. A.; Mat'yakubov, A. A.; Kuzieva, Kh.; Kazakov, S. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 6, 37-38(1972). (In Russian).

The copolymerization of vinyl fluoride (VF) and methyl acrylate (MA) and butyl acrylate was investigated and the constants of copolymerization were determined. These tests were conducted in glass without admitting air, and were irradiated with a ^{60}Co source at 50 R/sc. The yields of copolymers were linear with time of irradiation up to the termination of the testing (15 min), suggesting that the rate of formation of radicals from the monomers remained constant in spite of an increase in time of irradiation. The rate of copolymerization of VF + MA was somewhat greater than that of VF + BA. The composition of the copolymer was studied as a function of the initial ratio of the two monomers. (KSW)

11824 MICELLAR EFFECTS ON $Cl_2^{\cdot-}$ REACTIVITY. REACTIONS WITH SURFACTANTS AND PYRIMIDINES. Patterson, L. K.; Bansal, K. M.; Bogan, G.; (and others) (Carnegie-Mellon Univ., Pittsburgh). J. Amer. Chem. Soc.; 94: No. 26, 9028-32(27 Dec 1972).

Reactivities of $Cl_2^{\cdot-}$ with micelle-forming surfactants and with uracil, 5-chlorouracil, thymine, cytosine, and cytidine both in aqueous and micellar systems were investigated. Rate constants for initial reactions of $Cl_2^{\cdot-}$ with surfactants and with these pyrimidines were measured by pulse radiolysis where possible. Steady-state studies of competition between pyrimidines and surfactants for $Cl_2^{\cdot-}$ were carried out by determination of G(−pyrimidine) following Co-60 γ-cell irradiation. It was shown by combining data from these two methods that $k_{Cl_2^{\cdot-}+surfactant}$ is smaller above the critical micelle concentration than below it. Although little or no micellar effect is observed on the initial reaction between $Cl_2^{\cdot-}$ and uracil or its derivatives (thymidine and 5-chlorouracil), it is evident that there is interference which in subsequent processes lowers G(−pyrimidine). In cytosine and cytidine systems some initial effects are evident at concentrations of these compounds of about 5×10^{-3} M. In addition, G(−cytosine) and G(−cytidine), in the presence of micellar hexadecyltrimethylammonium chloride, are greater than in the presence of monomeric surfactant. (auth)

11825 CHEMILUMINESCENCE FROM THE REACTION OF THE HYDRATED ELECTRON WITH TRIS(BIPYRIDYL)-RUTHENIUM(III). Martin, J. E. (Argonne National Lab., IL); Hart, E. J.; Adamson, A. W.; Gafney, Harry; Halpern, Jack. J. Amer. Chem. Soc.; 94: No. 26, 9238-40(27 Dec 1972).

The chemiluminescence from the reaction of tris(bipyridyl)-ruthenium(III) with hydrated electrons produced in He- or N_2O-saturated solution by 4 to 40 nsec single pulses of 15-MeV electrons was studied. The radiative lifetime, τ, for the $e_{aq}^- + Ru(bipy)_3^{3+}$ produced emitter was determined at all experimentally monitored wavelengths and consistently found to be 0.58 μsec at 25°C. It was concluded that the excited state produced by the reaction is essentially the same ^3CT state observed in emission studies. (DHM)

11826 CONFORMATIONAL EFFECTS IN THE ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF CYCLOHEXANONYL RADICALS IN ADAMANTANE. Camaioni, D. M.; Pratt, D. W.

(Univ. of Pittsburgh). Contract AT(11-1)-3435. J. Amer. Chem. Soc.; 94: No. 26, 9258-60(27 Dec 1972).

Cyclohexanoyl radicals were produced by room temperature x-irradiation of a solid pellet of carefully purified adamantane containing a small amount of ketone. The radicals, formally obtained by removal of a hydrogen atom from the C-2 position, undergo conformational interconversions between the two half-chair forms. At 93°K the interconversion is slow and the radical exhibits three inequivalent protons with hfsc of $a_\alpha = 18.1$, $a_{\beta_1} = 23.5$, and $a_{\beta_2} = 43.4$ G. Increasing of the temperature increases the rate of interconversion which results in the broadening and eventual loss of the center multiplet near 193°K. This multiplet then reappears as a doublet at still higher temperatures and narrows further as the spectrum approaches the high temperature limit expected for a single α proton and two equivalent β protons with $a_\alpha = 18.0$ and $a_\beta = 33.0$ G at 313°K. Conformational effects were also observed in the EPR spectra of several substituted cyclohexanonyl radicals. (DHM)

11827 ELECTRON PARAMAGNETIC RESONANCE OF FREE RADICALS IN AN ADAMANTANE MATRIX. V. NEUTRAL ALKYLHYDRAZYL RADICALS. Wood, D. E. (Univ. of Connecticut, Storrs); Wood, C. A.; Lathan, W. A. J. Amer. Chem. Soc.; 94: No. 26, 9278-80(27 Dec 1972).

The EPR detection of neutral alkylhydrazyl free radicals, R_2NNH, which were produced by room temperature x-irradiation of the corresponding alkylhydrazines trapped in an adamantane matrix, are reported. The observation of hydrazyl radicals rather than amino radicals upon the x irradiation of hydrazines indicates that a different mechanism operates for the decomposition of hydrazines in the condensed phase under ionizing radiation, where there is N–H bond scission, than in gas-phase flash photolysis, electrodeless discharge, or very low pressure pyrolysis where N–N bond scission primarily occurs. (DHM)

11828 RADIATION-INDUCED COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH VINYL ETHERS. Hikita, Tomoji; Tabata, Yoneho; Oshima, Keichi; Ishigure, Kenkichi (Tokyo Univ.). J. Polym. Sci., Polym. Chem. Ed.; 10: No. 10, 2941-2949(Oct 1972).

Radiation-induced copolymerization of tetrafluoroethylene with various vinyl ethers was studied. It was found that tetrafluoroethylene can be copolymerized with vinyl ethers to give alternating copolymers over a wide range of the initial monomer concentration in the monomer mixture. The monomer reactivity ratios were determined for the copolymerization of tetrafluoroethylene with n-butyl vinyl ethers as 0.005 (r_{TFE}) and 0.0015 (r_{NBVE}). The rate of copolymerization is extremely high and has a maximum at an equimolar concentration of two monomers. The alternating structure of the copolymers was confirmed by the analysis of NMR spectra. Some thermal properties of the copolymers were measured by DSC and DTA. (auth)

11829 HIGH-TEMPERATURE AGING OF FLUOROPOLYMERS. Brown, D. W.; Wall, L. A. (National Bureau of Standards, Washington, DC). J. Polym. Sci., Polym. Chem. Ed.; 10: No. 10, 2967-2982(Oct 1972).

Fluoropolymers including those of 3,3,3-trifluoropropene, 2,3,3,3-tetrafluoropropene, 3,3,4,4,5,5,5-heptafluoropentene-1, and their copolymers with tetrafluoroethylene, were aged in air and in its absence at 225 and 305°C. Intrinsic viscosities were measured before and after aging. Polymers of high tetrafluoroethylene content are most stable. In air the presence of tertiary hydrogens is associated with lowered stability but the presence of tetrafluoroethylene greatly mitigates this effect. Stress-relaxation studies in air of a vulcanizate of 3,3,3-trifluoropropene and tetrafluoroethylene cured by γ-rays indicate that the vulcanizate degrades much more rapidly than the untreated polymer. (auth)

11830 γ-RADIATION-INITIATED POST-POLYMERIZATION OF METHACRYLIC ACID IN THE SOLID STATE. Lando, J. B.; Semen, J. (Case Western Reserve Univ., Cleveland). J. Polym. Sci., Polym. Chem. Ed.; 10: No. 10, 3003-3016(Oct 1972).

The solid-state postpolymerization of slowly crystallized methacrylic acid was studied at 0°C with ^{60}Co γ-radiation as the initiator. The yield, molecular weight, molecular weight distribution, and stereosequencing of the polymer product were determined as a function of polymerization time. The narrow molecular weight distribution and the linear dependence of molecular weight on polymer yield were attributed to a polymerization mechanism characterized by both independent chain propagation and essentially no termination step. The overall polymerization rate was substantially faster than that reported previously for shock-crystallized monomer, a result which was attributed to termination by the occlusion of propagating radicals at defects in the shock-crystallized monomer. Although largely atactic, the polymer synthesized in the solid state contained a secondary kind of stereosequencing; the meso triad probability was highest at the end of the chain, where propagation had initiated and decreased continuously with chain growth. The gradient in stereosequencing along the chains was attributed to defects that were introduced into the monomer crystals by the growing polymer chains. (auth)

11831 RADIATION-INDUCED HETEROGENEOUS POLYMERIZATION OF ETHYLENE IN THE PRESENCE OF ETHYL ALCOHOL. Wada, Takeshi; Watanabe, Terutaka; Takehisa, Masaaki (Takasaki Radiation Chemistry Research Establishment, Japan). J. Polym. Sci., Polym. Chem. Ed.; 10: No. 10, 3039-3052(Oct 1972).

The radiation-induced heterogeneous polymerization of ethylene in ethyl alcohol was carried out in a reactor with a capacity of 100 ml under the following reaction conditions: temperature, 24 ± 3°C; pressure, 200 to 400 kg/cm^2; amount of ethyl alcohol, 30 to 70 ml; dose rate, 3.7×10^4 to 1.05×10^5 rad hr. The effects of amount of ethyl alcohol, pressure, and dose rate on the rate of polymerization at the steady state, the amount of polymerized monomer, the molecular weight of polymer, and the number of polymer chains were studied compared with the results obtained in the polymerization in tert-butyl alcohol. It was found that there is an acceleration period in the early stage of reaction followed by a steady state. The rate of polymerization was maximum when about 50 ml of ethyl alcohol was used. The molecular weight of polymer increased with a decrease in the amount of ethyl alcohol. The dependences of pressure (p) and dose rate (I) on the rate of polymerization at steady state (R_s) and the molecular weight of polymer ($\overline{M}_n$) were expressed as follows; $R_s \propto p^{0.74}$, $\overline{M}_n \propto p^{0.3-0.4}$, $R_s \propto I^{0.9}$ and $\overline{M}_n \propto I^{-0.1-0.0}$. The results were analyzed by a kinetic treatment based on a reaction mechanism containing both first- and second-order terminations. The rate constant of first-order termination by radical occlusion was considerably larger than that in the polymerization in tert-butyl alcohol, because the affinity of ethyl alcohol for polyethylene is smaller than that of tert-butyl alcohol. It was found that chain transfer to ethyl alcohol takes place easily and the G value of ethyl alcohol for initiation is larger than 1.5. (auth)

11832 MOLECULAR WEIGHT DISTRIBUTIONS IN RADIATION-INDUCED POLYMERIZATION. VII. γ-RAY-INDUCED POLYMERIZATION OF WET STYRENE IN THE SOLID STATE. Westlake, J. F.; Huang, R. Y. (Univ. of Waterloo, Ont.). J. Polym. Sci., Polym. Chem. Ed.; 10: No. 10, 3053-3066(Oct 1972).

Kinetic and molecular weight distribution results are reported for the γ-ray-initiated polymerization of styrene in the solid state. "In-source" polymerization over the temperature range −35°C to −55°C and post-polymerization at −35°C were investigated for "wet" styrene samples (water concentration $\approx 10^{-3}$ mole/l.). An interesting feature of the solid-state polymerization of styrene is the bimodal nature of the molecular weight distribution. On a qualitative basis the results resemble those obtained previously for the polymerization of rigorously dried ("dry") styrene. However, there are noticeable differences on a quantitative basis resulting from the considerable difference in the water content between wet and dry samples. On the basis of these studies, the kinetic and molecular weight distribution data were interpreted as being indicative of polymerization occurring simultaneously via free-radical and cationic mechanisms. (auth)

11833 ELECTRON SPIN RESONANCE SPECTRA OF RADICAL INTERMEDIATES IN THE OXIDATION OF ASCORBIC ACID AND RELATED SUBSTANCES. Laroff, G. P.; Fessenden, R. W.; Schuler, R. H. (Carnegie-Mellon Univ., Pittsburgh). J. Amer. Chem. Soc.; 94: No. 26, 9062-73(27 Dec 1972).

The radicals produced in the radiolysis of aqueous solutions of ascorbic, araboascorbic, reductic, and α-hydroxytetronic acids were examined by the in situ radiolysis–ESR method. Spectra of the ^{13}C-containing radicals were observed at the natural abundance level. These spectra show that in neutral and basic solutions oxidation produces radical anions in which the electron is spread over a highly conjugated tricarbonyl system. The radicals, which in these studies result mainly from the reaction of OH radicals, are identical with those previously found in other oxidation processes. For the radical from ascorbic acid the proton hyperfine structure consists of a 1.76 G doublet of 0.19 G triplets. In addition we have been able to resolve a further splitting of 0.07 G. The spectra in H_2O and D_2O are identical showing that each of these splittings is attributable to a CH proton. Examination of ascorbic-4-d_1 acid shows conclusively that the 1.76 G proton hyperfine constant is ascribable to the proton at the C_4 position. The splittings of 0.19 and 0.07 G are assigned to the protons at the C_5 and C_5 positions, respectively. The diastereomeric radicals produced from ascorbic and araboascorbic acids have observably different ESR spectra as a result of slightly different ^1H and ^{13}C hyperfine constants. In acidic solutions the radical produced from ascorbic acid persists in the anionic form down to a pH of 0. The pK for its protonation has been determined to be −0.45 so that protonation cannot be in-

volved in the pronounced increase in rate constant for radical disappearance observed in pulse radiolysis experiments in the pH region between 7 and 4. At pH values below 6 a second radical is also present in this system. This second radical, which appears to be formed specifically by reaction of OH radicals with the neutral form of ascorbic acid, has a protonation equilibrium with a pK of 2.0. (auth)

11834 HIGH ENERGY ELECTRON INDUCED EMISSION IN LOW TEMPERATURE GLASSES CONTAINING ADENINE. Fielden, E. M.; Lillicrap, S. C.; Smith, G. J. (Inst. of Cancer Research, Sutton, Eng.). Radiat. Res.; 52: No. 2, 219-28(Nov 1972).

The emission spectra and decay kinetics after pulsed electron irradiation of 10^{-3} M adenine in an ethylene glycol : water (EGW) glass and of the solvent glass itself were recorded at 80°K under different gas pressures down to 10^{-6} Torr. The effect of $NaNO_3$ and $HClO_4$ at several different concentrations on the luminescence from glasses with and without adenine was studied. $NaNO_3$ at low concentration reduced the yield of solvent glass luminescence by an order of magnitude but had little effect on the adenine emission. High concentrations of both $NaNO_3$ and $HClO_4$ were required to reduce the phosphorescence yield of adenine. The excited state responsible for the long-lived emission from the solvent is formed by a process involving mobile electrons, probably a charge recombination process, while the triplet state of adenine is populated either by direct excitation by slow electrons or by geminate ion pair recombination. (auth)

11835 INFLUENCE OF γ-IRRADIATION UPON CATALYTIC SELECTIVITY. I. OXIDATION OF ETHYLENE OVER SUPPORTED SILVER. Carberry, J. J.; Kuczynski, G. C.; Martinez, Enrico (Univ. of Notre Dame, IN). J. Catal.; 26: No. 2, 247-53 (Aug 1972). (COO-38-808).

The yield of ethylene oxide in the oxidation of ethylene over a commercial (Engelhard) supported catalyst is significantly enhanced by preirradiation of the catalyst in a ^{60}Co γ source. The effect is reversible in that reduction in H_2 and reoxidation restores normal behavior and reirradiation in air restores the enhancement. Electron spectroscopy chemical analysis studies reveal that irradiation prompts the appearance of Ca on the surface, which rediffuses into the bulk on reduction and reappears on reirradiation. The observed yield of ethylene oxide enhancement is attributed to chemisorbed superoxide (of Ca) formation on the surface, a postulate in accord with the speculation that ethylene oxide is generated via surface O_2^- sites. (auth)

11836 MODEL OF RADIATION SENSITIZATION BY QUINONES. Simic, M.; Hayon, E. (Univ. of Texas, Austin). Int. J. Radiat. Biol.; 22: No. 5, 507-11(Nov 1972).

The electron transfer processes to menaquinone (vitamin K_3) were studied and the literature reviewed. The results are tabulated for the following free radicals produced from the reaction of OH radicals with compounds of biological interest in aqueous solution: formates, isopropyl, alcohol, ribose, deoxyribose, ribose-5-phosphate, glycine, glycine amide, glycine anhydride, uracil, dihydrouracil, thymine, dihydrothymine, TMP cytosine, isocytosine, CMP, orotic acid, benzoic acid. It is suggested that menaquinone fits the requirement of an efficient radiation sensitizer due to its capacity to react with free radicals produced by a one-electron oxidation process. (UK)

11837 MECHANISM OF BUdR SENSITIZATION: A PULSE RADIOLYSIS STUDY OF ONE ELECTRON TRANSFER IN NUCLEIC-ACID DERIVATIVES. Adams, G. E.; Wilson, R. L. (Mount Vernon Hospital, Northwood, Eng.). Int. J. Radiat. Biol.; 22: No. 6, 589-97(Dec 1972).

Stationary-state and pulse-radiolysis competition experiments are described, which provide a basis for the study of one-electron transfer from free radical ions derived from various pyrimidine and purine derivatives to their brominated analogues. Bimolecular rate constants in the range 0.3 to 1.1×10^9 M^{-1} sec^{-1} are reported for electron transfer. Reactions involving only the free bases are somewhat faster than those involving the corresponding nucleosides. Transfer from the cytosine electron-adduct to bromouracil was too slow to be observed by this pulse-radiolysis competition technique. The results are discussed in terms of current mechanisms of radiosensitization. (auth)

11838 VISIBLE LIGHT SPECTROSCOPIC STUDY OF STRUCTURES OF TRAPPED RADICALS IN IRRADIATED POLY(VINYL ALCOHOL). Yoshitake, T. (Kuraray Co. Ltd., Okayama, Japan); Imai, K.; Ukida, J.; Matsumoto, M. Kobunshi Kagaku; 29: No. 7, 467-71(Jul 1972). (In Japanese).

Structure of trapped radicals in irradiated poly(vinyl alcohol) was studied by observation of absorption bands at 335, 375, and 400 to 500 mμ. The films irradiated in air or vacuum had the same absorption bands. An oxygen effect on the absorption spectrum was not observed. The effect of irregular bonds in poly(vinyl alcohol) on the absorption bands induced by the irradiation was studied. The carbonyl group had no effect but the 1,2-glycol bond had marked influences on the absorption spectrum. Films with added sodium acetate had absorption bands at 375 mμ and 400 to 500 mμ but not at 335 mμ on irradiation. The absorption band at 335 mμ is assigned to $\sim\dot{C}(=O)-C(OH)\sim$ and those at 375 and 400 to 500 mμ are assigned to $\cdot C(=O)-(CH=CH)_n\sim$. Decay of the trapped radical in the irradiated polymer was measured when styrene was graft copolymerized on it. (auth)

11839 RECENT DEVELOPMENT OF CHEMONUCLEAR REACTOR STUDY. Danno, A. (Japan Atomic Energy Research Inst., Takasaki, Japan). Genshiryoku Kogyo; 18: No. 8, 27-32 (Aug 1972). (In Japanese).

General concepts and classifications of chemonuclear reactors are given. Various chemical reactions appropriate for chemonuclear reactors are listed together with their theoretical and experimental G-values and thermal efficiency. Activation of nitrogen by radiation and associated synthesis of organic nitrogen compounds were systematically studied. Gamma radiation from ^{60}Co and mixed radiation in reactors were used as the source of radiation. Gas dosimeters for measuring γ radiation, fast neutrons, and thermal neutrons were also developed. For low-temperature irradiation in the JRR-3 irradiation hole, a loop was constructed. Using this loop, a system of nitrogen and ethylene was irradiated by fission fragments to yield HCN and the G-value of 0.23 was observed. (Japan)

11840 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE ONTO LIGNIN. Sakata, I. (Kyushu Univ., Fukuoka); Sobue, H. Kobunshi Kagaku; 29: No. 7, 495-500 (Jul 1972). (In Japanese).

Simultaneous radiation grafting of styrene on lignin, (I), lignosulfonate (II), thiolignin (III), methylated lignin, and sulfidated lignin, was studied. Lignin-styrene graft copolymer was isolated from the irradiation products by extraction of the homopolystyrene and unreacted lignin using benzene and solvents for lignin. Grafting scarcely occurred when I, II, and III were irradiated in bulk styrene, but it proceeded readily in several styrene-solvent systems e.g., methanol for I, II, and III, acetic acid for I, acetone for II, and dioxane for III. Grafting was greatly enhanced when the disulfide group (–S–S–) having high chain-transfer constant was introduced to I by sulfidation with hydrogen sulfide, or when the phenolic hydroxyl group in lignin was methylated. The grafted polystyrene was isolated by oxidative degradation of the lignin backbone with peracetic acid. There was no marked difference between the degrees of polymerization of the grafted polystyrene and of the homopolystyrene. Polymerization kinetics of both polystyrenes were almost the same. From the infrared spectra, the ratio of lignin backbone vs. polystyrene branches in the graft copolymer was estimated as 1 : 1, and the active grafting site in lignin is discussed. (auth)

11841 ESTIMATION OF LONG CHAIN BRANCHES IN POLYETHYLENE POLYMERIZED BY GAMMA-RAY IRRADIATION. Hosoi, M. (Teijin Ltd., Sagamihara, Japan); Naoi, T.; Kawai, T.; Kuriyama, I. Kobunshi Kagaku; 29: No. 328, 551-7(Aug 1972). (In Japanese).

Polyethylene samples polymerized at different temperatures by γ radiation in the gas phase were fractionated by a column fractionation method. Molecular weight distributions of the fractions were determined and intrinsic viscosities and average molecular weights were measured. The number of long chain branches increased with increasing molecular weight of the fraction and was larger for the fractions of the sample polymerized at 60°C than those prepared at 30°C. The sample polymerized at 90°C had very few long branches. On the other hand, strong dependence of the number of the short branches on polymerization temperature was observed. (auth)

11842 CRYSTALLIZATION BEHAVIOR OF SHORT AND LONG CHAIN BRANCHES OF POLYETHYLENE POLYMERIZED BY GAMMA-RAY IRRADIATION. Hosoi, M. (Teijin Ltd., Sagamihara, Japan); Naoi, T.; Kawai, T.; Kuriyama, I. Kobunshi Kagaku; 29: No. 328, 557-61(Aug 1972). (In Japanese).

The effects of long chain branches of polyethylenes polymerized by γ-irradiation in the gas phase on their crystallization behavior were studied and the configurations of the polymers thus estimated are discussed in relation to the polymerization mechanism. The crystallization and melting temperatures of the fractions reflect the dependence of the concentration of CH_2 on the molecular

weight and decrease with increasing polymerization temperature, reflecting the number of the short branches. For higher molecular weight fractions, however, the long branches affect the results. Molecular weight dependences of the densities and melting temperatures of the melt-crystallized fractions were similar to that of the crystallization temperature. It is postulated that the long chain branches are formed by a graft reaction through the chain transfer of the radicals formed in the polymer already precipitated. The number of long branches in the polymer obtained at 60°C are larger than those prepared at 30°C. At 90°C the graft reaction takes place very rapidly and the polymers obtained have only short chain branches and lower molecular weight. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstract 13483.

Hot-Atom Chemistry

Refer also to abstract 11805.

11843 (COO-2190-3) GAS PHASE REACTIONS OF NUCLEAR RECOIL PRODUCED SULFUR ATOMS WITH SIMPLE HYDROCARBONS, HYDROGEN, AND OXYGEN. Kremer, Larry; Spicer, Leonard (Utah Univ., Salt Lake City. Dept. of Chemistry). [nd]. Contract AT(11-1)-2190. 9p. (CONF-720821-4). Dep. NTIS.

From 164th National American Chemical Society meeting; New York, NY (27 Aug 1972).

Recoil methods were used to study reactions of low-energy and thermal sulfur atoms with gases. ^{35}S was produced both by (n,p) reactions with ^{35}Cl and by (n,γ) reactions with ^{34}S. When no ethylene was present, the recoil sulfur reacted with hydrogen to produce hydrogen sulfide in 60 to 70% of the volatile sulfur yield. With the addition of 2.5% ethylene scavenger, the total yield of volatile sulfur was reduced markedly and no hydrogen sulfide was recovered. SO_2 and COS were produced readily in the presence of O_2 but were not observed in hydrocarbon systems excluding oxygen. Sulfur insertion into C–Cl bonds appeared to occur readily. (MCG)

11844 (COO-2190-4) CALCULATION OF PRODUCT YIELDS IN T + H_2 AND T + D_2 SYSTEMS. Malerich, C. J.; Spicer, Leonard (Utah Univ., Salt Lake City. Dept. of Chemistry). [nd]. Contract AT(11-1)-2190. 10p. (CONF-720821-5). Dep. NTIS.

From 164th National American Chemical Society meeting; New York, NY (27 Aug 1972).

The product yields of TH and TD in Ar-moderated T + H_2 and T + D_2 systems were calculated using $Y_i = f_i \int_{E_{1i}}^{E_{2i}} P_i(E)\, n(E)\, dE$ where i labels the reactive component, f_i is the collision fraction between the hot and thermal reactants, $P_i(E)$ is the reaction probability function, n(E) DE is distribution of hot species and E_{2i} and E_{1i} are respectively the maximum and minimum translational energies at which reaction can occur. (DHM)

11845 (COO-2190-5) COLLISION DENSITY IN RECOIL HOT ATOM SYSTEMS. EFFECT OF REACTIVE EVENTS. Malerich, C. J.; Spicer, L. D. (Utah Univ., Salt Lake City. Dept. of Chemistry). [nd]. Contract AT(11-1)-2190. 10p. (CONF-720821-6). Dep. NTIS.

From 164th National American Chemical Society meeting; New York, NY (27 Aug 1972).

Characteristics of the collisional distribution function for reactive hot atoms in nuclear recoil systems are examined and illustrated for the T + H_2 system both unmoderated and moderated with argon. Reaction-induced extrema are evident in the collision density of the unmoderated case. For this system depletion of hot atoms from the collisional distribution function due to reactive events is reflected significantly in the product yields even at high moderation. (auth)

11846 (COO-2190-6) DYNAMICS AND MECHANISMS OF HOT CHEMISTRY STIMULATED BY RECOIL METHODS. Progress Report, March 1, 1972–February 28, 1973. Spicer, L. D. (Utah Univ., Salt Lake City). 1972. Contract AT(11-1)-2190. 8p. Dep. NTIS.

Significant results were found and reported in three areas. The origin of the large deuterium isotope effect in methane and perdeuteriomethane was found to be primarily reactive in nature using the moderating technique with argon. The average probability of forming CH_3Cl upon collision compared with CD_3Cl is about 1.8 and that of forming CH_2Cl compared with CD_2Cl is about 1.6 in their respective systems. Characteristics of the collisional distribution function for recoil systems were examined. Inelastic collisional events were incorporated in the collision density and their effects are reflected in the hot reaction yields via the Miller–Dodson formula. Recoil reactions of sulfur atoms with chlorocarbons were observed to readily give sulfenyl chloride, RCSCl, products. In these studies a fast single pass chromatographic analysis was developed using tritolyl phosphate columns for the separation of H_2S, COS, SCl_2, sulfenyl chloride, and higher boiling mercaptans usually observed in recoil sulfur–hydrocarbon systems using chlorocarbon source molecules. (auth)

11847 METAL CARBONYL CHEMISTRY STUDIED WITH IMPLANTED IONS. Jenkins, G. M.; Wiles, D. R. (Carleton Univ., Ottawa). J. Chem. Soc., Chem. Commun.; No. 21, 1177(8 Nov 1972).

Bombardment of organometallic compounds with radioactive metal ions has been studied with a view to simulating the chemical effects of nuclear transformations; implantation of 4 keV $^{56}Mn^+$ ions into crystalline $Cr(CO)_6$ gives small yields (<1%) of $-Mn(CO)_5$ and $-Mn(CO)_4$. (auth)

11848 FIVE-CENTRE TRANSITION COMPLEX INVOLVING $\cdot N_2T$. Johnston, A. J. (Polytechnic, London); Urch, D. S. J. Chem. Soc., Chem. Commun.; No. 10, 585-6(24 May 1972).

The enhanced yield of labelled propylene observed when recoil tritium reacts with trans-but-2-ene in the presence of nitrogen is explained by postulating an excited $\cdot N = NT$, which can react with the olefin through a five-center transition complex to form $|C_4H_8T|^{\cdot *}$ and nitrogen and which decomposes in the usual way to form propylene. (auth)

Properties of Radioactive Materials

Refer also to abstract 11744.

11849 (JINR-P6-6685) POSSIBLE EXPRESS EXTRACTION OF EKATUNGSTEN AND EKARHENIUM FROM THE NUCLEAR REACTION PRODUCTS BY THE FRONTAL THERMOCHROMATOGRAPHY OF VOLATILE INORGANIC COMPOUNDS. Belov, V. Z.; Zvara, I.; Korotkin, Yu. S.; Shalaevskii, M. R.; Shchegolev, V. A.; Domanov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

Conditions were found for the continuous express extraction of tungsten and rhenium by frontal thermochromatography of volatile inorganic compounds of these elements. (auth)

11850 (KFK-1657) MIXED COMPLEXES AND HIGHER UNILIGAND COMPLEXES OF FIVE VALENT NEPTUNIUM: THE COORDINATION NUMBER OF NpO_2^+ IONS. Stoeber, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Jul 1972. 71p. (In German). Dep. NTIS (U. S. Sales Only).

Complex compounds of pentavalent neptunium with one species of ligand ("uniligand complexes") and two species of ligand ("mixed complexes") were investigated by spectrophotometry and their stability constants were calculated. The coordination number of pentavalent neptunium was estimated by comparison of the complexes with different types of ligands. The following types of complexing agents were studied: monocarboxylic acids, aminocarboxylic acids, hydroxycarboxylic acids, dicarboxylic acids, aminopolycarboxylic acids, tricarboxylic acids, dihydroxybenzene compounds, and β-diketones. It was possible to prove the existence of uniligand complexes of composition $(NpO_2)L$, $(NpO_2)L_2$, $(NpO_2)L_3$ (L = ligand). The maximum coordination number of the neptunyl(V) cation in these compounds probably is five, but coordination number six cannot be excluded with certainty. In the investigation of mixed complexes nitrilotriacetic acid (H_3NTA) has been used as the primary ligand. It is shown that all secondary ligands investigated form mixed complexes, having the general constitution $(NpO_2)(NTA)(A)$ (A = secondary ligand). It was not possible to demonstrate the addition of more than one secondary ligand molecule in any case. The maximum coordination number of neptunyl(V) cation in these mixed complex compounds results to be five. (auth)

11851 (LA-DC-72-1517) ELUCIDATION OF ACTINIDE FLUORIDE STRUCTURES USING SINGLE CRYSTAL X RAY AND OPTICAL MICROSCOPY TECHNIQUES. Penneman, R. A.; Ryan, R. R. (Los Alamos Scientific Lab., N. Mex.). 1972. 21p. (CONF-720931-3). Dep. NTIS.

From Symposium on the chemistry of the transuranium elements; Moscow, USSR (4 Sep 1972).

Fluoro complexes of the M^{4+} ions, Th, U, and Ce (order of decreasing radius) were prepared from aqueous NH_4F and MF_4. Their complexes show striking differences in coordination of the M^{4+} element. Thorium is 9-coordinated in tricapped trigonal prisms occurring as chains in $4NH_4F \cdot ThF_4$ and in $3NH_4F \cdot ThF_4$. The smaller ions, U^{4+} and Ce^{4+}, display a variety of 8-

coordinated structures, e.g., isolated MF_8^{4-} ions in $4NH_4F \cdot MF_4$, 8-coordinated chains in $2NH_4F \cdot MF_4$; and dodecahedral dimers in $Ce_2F_{14}^{6-}$. The first known example of actinide fluoride dimer units occur in the lattice of cubic $7NH_4F \cdot 2ThF_4 \cdot H_2O$. Two thoriums are located on the cube diagonal, sharing a triangle of three fluorines between them. Each thorium is additionally coordinated by puckered equatorial ring of six fluorines. Although the x-ray crystal structures of actinide fluoride complexes differ greatly, molar refractivity is a good measure of their composition since wide structural variations have little effect on the molar refractivity. (auth)

11852 (ORNL-TM-4056) EQUILIBRIUM OF DILUTE UF_3 SOLUTIONS CONTAINED IN GRAPHITE. Toth, L. M.; Gilpatrick, L. O. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 35p. Dep. NTIS.

The equilibrium of dilute UF_3-UF_4 molten fluoride solutions in contact with graphite and UC_2, $3UF_4 + UC_2 \rightleftharpoons 4UF_3 + 2C$, was studied as a function of temperature (370 to 700°C), melt composition and atmospheric contamination. Equilibrium quotients, $Q = (UF_3)^4/(UF_4)^3$ for the reaction were determined by measuring the UF_3 and UF_4 concentrations spectrophotometrically. The solvents used were primarily $LiF-BeF_2$ mixtures. Results from this solvent system were related to the reactor solvents $LiF-BeF_2-ZrF_4$ (65.6–29.4–5 mole %) and $LiF-BeF_2-ThF_4$ (72–16–12 mole %). The equilibrium quotient was very sensitive to both temperature and solvent changes increasing as either the temperature increased or the alkali metal fluoride content of the solvent decreased. (auth)

11853 STUDY OF THE REDUCTION OF U(III) TO U(0) IN AQUEOUS SOLUTION BY RADIOCHEMICAL POLAROGRAPHY. Duflo-Plissonnier, M.; Samhoun, K. (Institut du Radium, Paris). Radiochem. Radioanal. Lett.; 12: No. 2-3, 131-8(29 Nov 1972). (In French).

Radiochemical polarography with the dropping mercury electrode shows the existence of two waves corresponding to the formation of the uranium amalgam. It is suggested that the first wave involves the formation of U(II). The second is a diffusion wave probably involving direct reduction of U(III) to U(Hg). (auth)

11854 RADIOCHEMICAL INVESTIGATION OF THE REACTION BETWEEN L-METHIONINE AND HYDROGEN SULFIDE. Samochocka, K.; Rudkowski, R. (Univ., Warsaw). Radiochem. Radioanal. Lett.; 12: No. 2-3, 121-9(29 Nov 1972). (In German).

The chemical reaction between L-methionine and hydrogen sulfide labeled with ^{35}S was studied. On variation of temperature and concentration of reagents, the order of the reaction, equilibrium constant, velocity constants, and the activation energy were determined. The product of the reaction was isolated and the structure of its molecule proposed. (auth)

11855 PREPARATION AND IDENTIFICATION OF PENTAVALENT PLUTONIUM IN BASIC MEDIUM. Bourges, J. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Radiochem. Radioanal. Lett.; 12: No. 2-3, 111-19(29 Nov 1972). (In French).

The behavior of the Pu(VI)–Pu(V) system in alkaline solutions were investigated. Contrary to earlier predictions, Pu(V) ions were stable in alkaline solutions. The formal potential of the Pu(VI)–Pu(V) system is 0.25 V/NHE in 4M NaOH. The disproportionation reaction Pu(IV) + Pu(VI) → 2Pu(V) was also observed in 4M NaOH solutions. (auth)

11856 HEAVY WATER. THERMOPHYSICAL PROPERTIES. Kirillin, V. A. (ed.). Jerusalem; Israel Program for Scientific Translations Ltd. (1971). 270p. (IPST-Cat.-5793).

Translated from Russian.

The thermophysical properties of heavy water (D_2O) are discussed under the following headings: properties of heavy water on the saturation line; the density of heavy water; calorimetric properties of heavy water; and viscosity and thermal conductivity of heavy water. Equations of state of heavy water and its vapor are included. The thermodynamic properties of heavy water in the saturation state as a function of temperature and pressure, in the single phase region, and in the ideal gas phase are presented in tabular form. A table of the specific heat of heavy water at constant pressure is also included. (E.R.B.)

11857 AMERICIUM(III) MOLYBDATE, $Am_2(MoO_4)_3$, AND REACTIONS WITH ALKALINE MOLYBDATES. Tabuteau, A.; Pages, M.; Freundlich, W. (Institut du Radium, Paris). Radiochem. Radioanal. Lett.; 12: No. 2-3, 139-44(29 Nov 1972). (In French).

Two allotropic modifications of $Am_2(MoO_4)_3$ were identified; one has a vacancy scheelite structure and the other an orthorhombic one. Through study of the americium(III) molybdate–alkali molybdate system, several new compounds were identified: two of them have a scheelite structure, $LiAm(MoO_4)_2$, $NaAm(MoO_4)_2$; one is superstructured, $Na_5Am(MoO_4)_2$, and two are phases not isostructural with the above, K_2MoO_4, $Am_2(MoO_4)_3$ and $5K_2MoO_4$, $Am_2(MoO_4)_2$. (auth)

11858 STABILIZATION OF ^{57}Fe AFTER ELECTRON CAPTURE BY ^{57}Co IN BARIUM ORTHOCOBALTATE(IV). Kulikov, L. A.; Perfilev, Yu. D.; Afanasov, M. I.; Babechkin, A. M. (Univ., Moscow). Radiochem. Radioanal. Lett.; 12: No. 1, 47-52(9 Nov 1972). (In French).

The chemical consequences of the ^{57}Co EC in Ba_2CoO_4 were studied. No valent forms different from the parent one were observed. (auth)

11859 DETERMINATION OF THE FORMATION CONSTANTS OF ACTINOID AND LANTHANOID LACTATE COMPLEXES BY MEANS OF ELECTROPHORESIS. Sakanoue, M.; Nakatani, M. (Kanazawa Univ., Japan). Bull. Chem. Soc. Jap.; 45: No. 11, 3429-33(Nov 1972).

Determination of the complex formation constant of actinides (Am, Cm) and lanthanides (Pm, Eu, Lu) with lactic acid was carried out by means of the electrophoretic method. "Cellogel," a gelatinized cellulose acetate was used as the supporting medium for electrophoresis at 10°C. Electrolyte solutions of various pH at an ionic strength of 1.5 were prepared from 0.5M lactic acid solution for electrophoresis at various pH values. The migration zones of α- and β-emitter were determined by α track on cellulose nitrate and autoradiographic image on x-ray film, respectively. The mobility of each nuclide at different pH was analyzed to obtain the formation constants of lactate complex of each element with reference to dissociation equilibrium. The β_1 values thus obtained were consistent with those obtained by other methods. The method was found to be especially useful for determining the complex formation constants of trans-uranium elements with only tracer amounts of these elements. (auth)

11860 STUDY OF CATALYSIS BY URANIUM OXIDE AND ITS MIXED CATALYSTS. III. A COMPARISON OF THE URANIUM OXIDE CATALYST WITH VANADIUM OXIDE, MOLYBDENUM OXIDE, AND TUNGSTEN OXIDE CATALYSTS FOR THE CATALYTIC OXIDATION OF CARBON MONOXIDE. Nozaki, F.; Ohki, K. (Chiba Univ., Japan). Bull. Chem. Soc. Jap.; 45: No. 11, 3473-4(Nov 1972).

A survey is made of the oxidation activity of U_3O_8, V_2O_5, MoO_3, and WO_3 catalysts, and the causative relationship between catalytic activity and the thermodynamic properties of the oxides, such as the heat of formation or the heat of oxide interconversion, is discussed. Results show that U_3O_8 is exceedingly high in oxidative activity and the order of catalytic activity is as follows: $U_3O_8 > V_2O_5 > MoO_3 > WO_3$. (DHM)

11861 KINETIC STUDY OF THE REDUCTION OF BROMATE ION BY NEPTUNIUM(V) IN PERCHLORATE SOLUTION. Knight, G. C.; Thompson, R. C. (Univ. of Missouri, Columbia). Inorg. Chem.; 12: No. 1, 63-6(Jan 1973).

The empirical form of the rate law for the reaction 4Np(V) + Br(V) = 4Np(VI) + Br(I) at 25°C in perchloric acid–lithium perchlorate solutions is $-d[Br(V)]/dt = k_0[Br(V)]^2[H^+]^{1.51}$. This expression adequately correlates the kinetic data from 10 to 90% reaction over a large range of initial reactant concentrations. At least one induction period is observed. A complex reaction scheme is proposed in which the rate parameter is identified as $[k_a^2[H^+]^2/4k_{c_0}]/[1 + (k_{c_1}/k_{c_0})[H^+]]$, where k_a is the rate constant for the reaction between bromate ion and a bromous acid intermediate, and k_{c_0} and k_{c_1} are rate constants of parallel paths for the disproportionation of the same intermediate. Comparisons with other systems in which bromate ion is reduced by weak one-electron reductants are made. (auth)

11862 NEUTRONICS OF IRRADIATED FUELS. Robin, M. (CEN, Fontenay-aux-Roses, France); Luffin, J. Bull. Inform. Sci. Tech. (Paris); No. 170, 51-9(May 1972). (In French).

Physicochemical analysis of irradiated fuels yields important information on the properties of reactors during operation. Such analysis plays an important role in reactor physics as comparisons between measured and calculated values provide a means of verifying the validity of the formulas used. Analytical methods (isotopic dilution, α and γ spectrometry) are described; applications to the study of particular parameters are discussed. (France)

11863 NEUTRON DIFFRACTION STUDY OF THE ANISOTROPIC THERMAL EXPANSION OF β-URANYL DIHYDROXIDE. Taylor, J. C.; Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Acta Crystallogr., Sect. B; 28: No. 10, 2995-9(1972).

Neutron diffraction powder patterns were taken to obtain positional parameters for all the atoms in $\beta-UO_2(OH)_2$ at six temperatures from 21 to 260°C. The results confirm that the strongly anisotropic thermal expansion of this material is caused by the rotation of oxygen octahedra in the structure. These octahedra

also undergo temperature-induced shape changes, which may be attributed to the effects of hydrogen bonding in the structure. (auth)

11864 EQUILIBRIUM STUDIES OF MIXED-LIGAND COMPLEXES OF URANYL ION AQUEOUS SOLUTION. Selvaraj, P. V. Santappa, M. (Univ. of Madras). Curr. Sci. (India); 41: No. 24, 872(20 Dec 1972).

Results of equilibrium studies of mixed ligand complexes of uranyl ions show that in the case of UO_2^{2+}–formic acid–ligand$_2$ (the ligand$_2$ being benzoic, phenylacetic, hydrocinnamic, phenoxyacetic, and p-hydrosybenzoic acids), the stability constants of the mixed ligand complexes are of the order: (ligand$_2$) hydrocinnamic > phenylacetic > benzoic > phenoxyacetic > p-hydroxybenzoic acid. This is in accordance with that expected from the basicity of the ligand acids, excepting in the case of UO_2^{2+}–formic–phenoxyacetic acid complex where the higher stability may be attributed to the stabilization through the ether oxygen. In the case of UO_2^{2+}–hydrocinnamic acid–ligand$_2$ (ligand$_2$ being benzoic, phenylacetic, and p-hydroxybenzoic acids), the stability constants of the mixed complexes are of the order: (ligand$_2$) phenylacetic > benzoic > p-hydroxybenzoic acid, which is obvious from the basicity of the ligands. (D.H.M.)

11865 CHEMICAL EFFECTS OF THE DISINTEGRATION OF ^{35}S INCORPORATED INTO A DIETHYL SULFIDE MOLECULE. Kanski, R.; Pluciennik, H. (Univ. of Warsaw). Nukleonika; 17: No. 9, 459-65(1972). (In Polish).

The chemical effects of disintegration of ^{35}S, incorporated into double-labeled molecules $(^{14}C_2H_5)_2{}^{35}S$, were studied. The final products appearing according to the reaction scheme $(^{14}C_2H_5)_2{}^{35}S \xrightarrow{\beta^-} [^{14}C_2H_5ClC_2H_5]^+$ were detected by radiometric isotope dilution. In the gas phase at 0.5 Tr, 68 ± 11% of the primary molecular ions are stabilized in the form of C_2H_5Cl. The experimental results are discussed. (auth)

11866 HYDROLYSIS OF TETRAVALENT URANIUM. Glebov, V. A.; Klygin, A. E.; Smirnova, I. D.; Kolyada, N. S. Zh. Neorg. Khim.; 17: No. 12, 3312-16(Dec 1972). (In Russian).

The dependence of the longitudinal relaxation velocity of protons on pH and temperature in perchlorate solutions of U(IV) was studied by the spin echo method. An increase in the frequency of water exchange in the hydrate shell of U(IV) occurred as a result of hydrolysis. Absorption spectra of U(IV) solutions were obtained at different pH values and the dependence of optical density on pH was evaluated. A polyhydroxy complex of U(IV) was formed under these conditions with $K_1 = 0.052$. (tr-auth)

11867 IODATE COMPOUNDS OF Np(V) AND Np(VI). Blokhin, V. I.; Bukhtiyarova, T. N.; Krot, N. N.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 12, 3317-23(Dec 1972). (In Russian).

Complex formation of Np(V) and Np(VI) with IO_3^- was studied by means of spectrophotometry and preparative methods. The complex NpO_2IO_3 + had a stability constant $K_1 = 4.1$ at 25°C and $\mu = 0.3$. The following were also synthesized: $NpO_2IO_3 \cdot 2H_2O$, $NpO_2IO_3 \cdot 5KIO_3 \cdot 2H_2O$, $NpO_2(IO_3)_2 \cdot 2H_2O$, $[Co(NH_3)_6]\,(NpO_2)_2(IO_3)_5 \cdot 4H_2O$, and $[Co(NH_3)_6]\,(NpO_2)_2(IO_3)_7 \cdot 7H_2O$. The synthetic methods are described, and solubility data are given. For $NpO_2(IO_3) \cdot 2H_2O$, the solubility in water was 5.8×10^{-3} mole. The stability of some of the complexes upon heating was investigated. (tr-auth)

11868 INFRARED ABSORPTION SPECTRA OF SOME NEPTUNIUM IODATES. Tsivadze, A. Yu.; Muchnik, B. I.; Krot, N. N. Zh. Neorg. Khim.; 17: No. 12, 3324-30(Dec 1972). (In Russian).

Infrared spectra were determined for the compounds $Np(IO_3)_4$, $NpO_2(IO_3) \cdot 2H_2O$, $NpO_2(IO_3)_2$, $UO_2(IO_3)_2$, $NpO_2(IO_3) \cdot 0.5KIO_3$, $Co(NH_3)_6(NpO_2)_2\,(IO_3)_5$, and $Co(NH_3)_6\,(UO_2)_2\,(IO_3)_7$ in the solid state. The iodate group in the majority of cases functions as a bridge. A bidentate iodate group occurs in the compound $NpO_2(IO_3) \cdot 2H_2O$. (tr-auth)

11869 APPARATUS FOR PRECIPITATION OF URANIUM COMPOUNDS FROM AQUEOUS SOLUTION. (to Nuklear-Chemie und -Metallurgie GmbH). German Patent 1,924,594. 19 Aug 1972. (In German).

An apparatus with nozzles is described for precipitation of uranium compounds from aqueous solutions. The nozzles are characterized in that outlet pipes below the liquid level flow from a circulating pump and from a mixing nozzle system into a flat container used as a precipitating vessel to which a washing apparatus is attached for the adsorption of liberated gases and aerosols. The ratio of the cross sections of the nozzle to the mixing pipe is between 1 : 3 and 1 : 5. The attached washer contains a mixing nozzle where the ratio of the cross sections of the nozzle to the inlet pipe is between 1 : 5 and 1 : 6. (GF)

11870 SYNTHESIS AND X-RAY STUDY OF SOME HEXAHALIDE COMPLEXES OF Tc(IV) AND Re(IV). Zaitseva, L. L.; Konarev, M. I.; Kozhevnikov, P. B.; (and others) Zh. Neorg. Khim.; 17: No. 9, 2411-15(Sep 1972). (In Russian).

The synthesis and roentgen analysis of the following compounds were accomplished: Me_2TcCl_6 (Me = K, NH_4, Rb, Cs), Me_2TcBr_6 (Me = K, NH_4), $(NH_4)_2TcI_6$, K_2ReX_6 (X = Cl, Br, I). $(NH_4)_2TcCl_6$, Rb_2TcCl_6, Cs_2TcCl_6, and $(NH_4)_2TcBr_6$ possess a face-centered cubic lattice with the constants: a = 9.936, 9.949, 10.237, and 10.417, respectively. The lattice constants for K_2MeX_6 (Me = Tc, Re; X = Cl, Br) agree with published literature data. (tr-auth)

11871 OCTATHIOCYANATO- AND OCTASELENOCYANATO-COMPLEXES OF THE TETRAVALENT ACTINIDE ELEMENTS. Al-Kazzaz, Z. M. S. (Univ. of Manchester, Eng.); Bagnall, K. W.; Brown, D.; Whittaker, B. J. Chem. Soc., Dalton Trans.; No. 20, 2273-7(1972).

Octathiocyanato-actinide(IV) complexes of the types $(NEt_4)_4M(NCS)_8$ (M = Th, Pa, U, Np, and Pu) and $Cs_4M(NCS)_8$ (M = U and Pu) and the octaselenocyanato-complexes $(NEt_4)_4Pa(NCSe)_8$ and $(NEt_4)_4U(NCSe)_8$ have been prepared by reactions in non-aqueous media. Crystallographic and spectral results are reported for the complexes together with some chemical properties. (auth)

11872 LUMINESCENCE SPECTRA OF URANYL COMPOUNDS. Kizel, V. A.; Krasilov, Yu. I.; Burkov, V. I.; Madii, V. A.; Kapyrina, S. I. (Physical-Technical Inst., Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 5, 1034-6(May 1972). (In Russian).

The mechanism of the initiation of electron-vibration luminescence spectra of uranyl compounds was examined. A homological series of compounds with a cubic crystalline lattice and similar types of ligands was chosen for the study: $MuO_2(C_2H_5COO)_3$, $NaUO_2(CH_3COO)_3$, and $MUO_2(C_3H_7COO)_3$, where M = Cs, Rb, NH_4, K, or Tl. The intensity of the series of vibrations depended on the magnitude of the deformation of the uranyl complex from D_{6h} to C_3. (tr-auth)

11873 DETERMINATION OF THE IGNITION TEMPERATURES OF THE REACTIONS $CaUF_6$ + Mg AND $CaUF_6$ + Ca. Rafalski, W.; Syryczynska, B. (Inst. of Nuclear Research, Warsaw). Nukleonika; 17: No. 7-8, 377-82(1972).

The reduction of $CaUF_6$ by means of Mg runs in two steps. The ignition temperatures of these step reactions are 480 to 530 and 670 ± 10°C, respectively. The ignition temperature of the reaction of $CaUF_6$ with Ca is between 840 to 855°C. (auth)

Radioactive Waste Treatment

Refer also to abstract 11739.

11874 (AAF-TR-7102) IMPREGNATED ACTIVATED CARBON (AAF TYPE 2701) FOR REMOVAL OF RADIOIODINE COMPOUNDS FROM REACTOR CONTAINMENT ATMOSPHERES. Rivers, R. D. (ed.) (American Air Filter Co., Inc., Louisville, Ky.). 1 Sep 1972. 47p.

Test procedures used to define the parameters of activated carbons for reactor containment service are described. The results of these tests performed on a specific grade of iodized coconut shell activated carbon, AAF 2701, are presented. A set of quality control acceptance levels for this material is listed. (auth)

11875 (WASH-1231) EVALUATION OF DATA REGARDING THE EFFICIENCY OF ACTIVATED CHARCOAL ADSORBERS AT LOW GAS PHASE IODINE CONCENTRATION. Final Report. Ritzman, R. L.; Genco, J. M. (Battelle Columbus Labs., Ohio). 31 May 1972. Contract W-7405-eng-92. 37p. Dep. GPO $0.75.

In an effort to assess the effect of iodine and methyl iodide concentration on the efficiency of charcoal beds for adsorbing and retaining these species at very low concentrations several reports of experimental work were reviewed and certain theoretical aspects of the adsorption process and adsorbed operation were examined. The principal conclusion of the study is that over the specified range of gas phase iodine concentrations (i.e., 10^{-8} $\mu g/m^3$ to 10^5 $\mu g/m^3$), present experimental and theoretical knowledge offer no concrete basis for the existence of a purely concentration-dependent isotherm for either elemental iodine or methyl iodide. If concentration-dependent adsorption efficiencies are observed, the cause is one or more secondary effects which either lead to a change in iodine form or alter the primary adsorption isotherm by changing physical conditions in the system. (DHM)

Radioisotope Production

Refer also to abstracts 11776 and 13551.

11876 ISOTOPE GENERATORS. PRESENT STATUS AND FUTURE DEVELOPMENT. Henry, R. (CEA de Saclay, Gif-sur-Yvette, France). J. Nucl. Biol. Med.; 15: No. 4, 105-7 (1971).

The development of isotope generators is reviewed. Discussions and information are presented on nuclear characteristics, chemical characteristics, and prospects for future development. (J.R.D.)

11877 EXTRACTION OF ^{32}P FROM IRRADIATED SULFUR BY PARAFFIN. Abrarov, O. A.; Zhuravlev, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 10, 25-7(1971). (In Russian).

Extraction of ^{32}P from irradiated S was achieved by dissolving the mixture in paraffin at 95°C (30 min), and then extracting the ^{32}P with 6M HCl. The yield of recovered ^{32}P = 94%. Paraffin was found to be superior to the following organic solvents: C_2HCl_3, $CHCl_3$, C_6H_6, $C_6H_5NH_2$, $C_{10}H_{18}$, and CS_2. (K.S.W.)

11878 LARGE-SCALE SEPARATION OF TRANSPLUTONIUM ACTINIDES BY PRESSURIZED CATION EXCHANGE. Harbour, R. M.; Hale, W. H.; Burney, G. A.; Lowe, J. T. (E. I. du Pont de Nemours and Co., Aiken, SC). Contract AT(07-2)-1. At. Energy Rev.; 10: No. 3, 379-99(Sep 1972).

A brief history of pressurized ion exchange separations is presented and the advantages of pressurized cation exchange compared to conventional cation exchange are discussed. In reviewing present applications of pressurized cation exchange, a 100-g scale separation of ^{244}Cm, a multigram-scale separation of transplutonium elements, and a milligram-scale separation of transcurium elements are discussed in detail. Other applications of pressurized cation and anion exchange are also presented. (auth)

11879 PREPARATION OF ^{233}U. Ishimori, T.; Ueno, K.; Kimura, K.; (and others) (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol.; 9: No. 12, 716-20(Dec 1972).

Thorium dioxide amounting to 1.3 kg was irradiated for 241 days at an average neutron flux of 6×10^{10} n/cm^2 · sec, and allowed to stand for 1.2 yr. This cooling lowered the γ activity of the irradiated ThO_2 sufficiently to permit handling without special shielding. Nine milligrams of ^{233}U were extracted with TBP in dodecane, and determined by α counting. The mass ratio of the uranium isotopes obtained was determined by mass spectrometry. It was indicated that the ^{233}U was contaminated with natural uranium. (auth)

11880 ANION EXCHANGE SEPARATION OF ^{238}Pu AND ^{237}Np USING MACROPOROUS ANION EXCHANGE RESIN. Burney, G. A.; Thompson, G. H. (Savannah River Lab., Aiken, SC). Radiochem. Radioanal. Lett.; 12: No. 4-5, 207-14(20 Dec 1972).

Macroporous anion exchange resin yielded more efficient separation of ^{238}Pu from ^{237}Np than "Dowex" 1 gel-type resin in a nitrate system. (auth)

11881 STUDY ON THE PRODUCTION OF ^{52}Mn IN CARRIER-FREE STATE BY THE BOMBARDMENT OF ^{3}He PARTICLES ON CHROMIUM. Akiha, F. (Hirosaki Univ., Japan). Radioisotopes (Tokyo); 21: No. 12, 699-705(Dec 1972). (In Japanese).

To produce useful quantities of carrier-free ^{52}Mn, ^{3}He or α bombardment of natural chromium metal target was thoroughly studied. Activities of ^{52}Mn, ^{54}Mn, ^{56}Mn, and other nuclides were measured. Excitation curves and thick-target yield curves for formation of three manganese radionuclides were obtained. ^{52}Mn was mainly produced by (^{3}He,p2n) reactions on ^{52}Cr, the cross sections of which reached the maximum value of 220 mb at 33 MeV. For ^{54}Mn, an undesirable accompanied nuclide, the cross section was found to be 80 mb at 18 MeV. From excitation curves and operating conditions of the cyclotron, 40 MeV ^{3}He particles were chosen as the most suitable to give useful quantities of ^{52}Mn. Yield of 156 and 1.1 μCi/μAh of ^{52}Mn and ^{54}Mn, respectively, can be obtained. Thus ^{52}Mn separated in the carrier-free state was estimated to contain about 0.7% ^{54}Mn activity at the end of bombardment. ^{52}Mn can be separated and purified by anion exchange followed by distillation from a solution of chromium target and also by anion exchange from the ^{52}Fe solution, which contains ^{52}Mn as the decay product. In the latter case about 1 μCi of ^{52}Mn can be obtained from 1 mCi of ^{52}Fe, but it is free from ^{54}Mn. On α bombardment, ^{52}Mn was mostly produced by (α,pn) and (α,p3n) reactions on ^{50}Cr and ^{52}Cr, respectively. The maximum cross sections for the formation of ^{52}Mn and ^{54}Mn were found to be 35 mb at 27 MeV and 490 mb at 18 MeV. These two nuclides were produced with yields of 22 and 6 μCi/μAh, respectively, at 40 MeV. The ratio of ^{54}Mn activity to ^{52}Mn at the end of bombardment was found to be 27.3%, which was larger than that on ^{3}He bombardment. ^{3}He bombardment was superior to α bombardment on natural chromium. The yield of ^{52}Mn and the quantities of other by-produced nuclides were compared with those reported on proton or deuteron bombardments. It was concluded that 40 MeV ^{3}He bombardment on natural chromium metal was superior in giving useful quantities of ^{52}Mn with a reasonably high yield of 156 μCi/μAh and only accompanied with small quantities of ^{54}Mn (under 0.7%) at the end of bombardment. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 11722, 11743, 11961, and 13993.

11882 (ANL-Trans-932) REPROCESSING PROJECT: PYROCHEMICAL HEAD-END PROCESS-MOLTEN SALT ELECTROLYTIC CUTTING. Translation of a French report. 26p. Dep. NTIS.

Three head-end processes being studied for use in reprocessing fast fuels are discussed. These are: mechanical decladding and voloxidation, molten metal decladding and molten salt fuel lixiviation, and molten salt electrocutting. Design studies and laboratory experiments are described. (29 references) (M.C.G.)

11883 (DOCKET-50201-137) WEST VALLEY REPROCESSING PLANT. Exempted From 30 and 90 Day Reporting Periods, Change in Technical Specification Requires Additional Information, Technical Specifications, Change 15 Effective Date Deferred. (Directorate of Licensing (AEC), Washington, D. C.). 11 Dec 1972. 6p. Dep. NTIS.

Use of alternative time periods was determined to satisfy the purpose of 10 CFR 20.408 and will not result in undue hazard to life or property. Additional information is requested on proposed modifications to the fuel storage canisters, their loading, and spacing. The request for continuance under interim technical specification for liquid effluents was approved and the effective date of Change 15 deferred. (MCG)

11884 (GERHTR-39) REPROCESSING OF THORIUM-CONTAINING NUCLEAR FUELS. Activities Report for the First Six Months of 1969. (Kernforschungsanlage, Juelich (West Germany). Inst. fuer Chemische Technologie). Aug 1969. 92p. Dep. NTIS.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

GRAPHITE — flow behavior of fine-grain
PROTACTINIUM — separation from spent thorium-containing fuels in Thorex process
RADIOCHEMICAL PROCESSING PLANTS — analytical chemistry in, development of methods for
REACTOR FUEL ELEMENTS — combustion of graphite, in combined fixed bed-fluidized bed
— processing of, grinding, combustion, and leaching of silicon carbide-coated particles in head-end
REACTOR FUELS — reprocessing of thorium-containing, development of Thorex and Chlorinex processes for
— separation of protactinium from spent thorium-containing, in Thorex process
— reprocessing of thorium-containing, KFA-TBP 23/25 flowsheet for
— reprocessing of thorium-containing graphite, chlorination process in
SOLVENT EXTRACTION PROCESSES — development of TBP, for processing thorium-containing fuels
THOREX PROCESS — flowsheet development for
URANIUM — separation from spent fuels by solvent extraction using TBP (MCG)

11885 (GERHTR-41) REPROCESSING OF THORIUM-CONTAINING NUCLEAR FUELS. Activities Report for the Second Half Year 1969. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Feb 1970. 68p. Dep. NTIS.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

GRAPHITE — combustion in combined fixed-bed fluidized-bed furnace
PROTACTINIUM — separation from spent thorium-containing fuels
RADIOACTIVE MATERIALS — analysis of, development of methods for
RADIOACTIVE WASTE — processing of high-level, by solidification and glazing
REACTOR FUEL ELEMENTS — reprocessing of thorium-containing graphite, head-end combustion processes in
REACTOR FUELS — reprocessing of thorium-containing, Chlorinex, KFA-TBP 23/25, and Thorex processes for
— reprocessing of mixed oxide, molten salt dissolution in
— reprocessing of mixed oxide, chlorination process for
THOREX PROCESS — flowsheet development for

THORIUM — separation from spent fuels, evaluation of processes for
URANIUM — separation from nitric acid solutions by solvent extraction using TBP (M.C.G.)

11886 (GERHTR-43) REPROCESSING OF THORIUM-CONTAINING NUCLEAR FUELS. Activities Report for the Second Half Year 1970. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Feb 1971. 129p. Dep. NTIS.

Work Performed under United States-German High Temperature Reactor Research Exchange Program.

HOT CELLS — development for fabrication of irradiated and bred uranium
PROTACTINIUM — separation from spent thorium-containing fuels
RADIOACTIVE WASTE — processing of gaseous from Chlorinex reprocessing of thorium-containing fuels
— processing of high-activity aqueous, from fuel reprocessing
— solidification by roller drying or glass formation
RADIOCHEMICAL PROCESSING PLANTS — development of Jupiter, for processing thorium-containing fuels
REACTOR FUEL ELEMENTS — reprocessing of thorium-containing graphite, combustion processes for head-end
REACTOR FUELS — reprocessing of thorium-containing, Thorex, KFA-TBP 23/25, and Chlorinex flowsheets for
— reprocessing of mixed oxide, chlorination process for
— burnup analysis of thorium-containing
— burnup analysis of graphite, automatic device for
THOREX PROCESS — thorium determination in
— flowsheet development for
THORIUM — determination in Thorex fuel solutions
URANIUM — fabrication of irradiated and bred, following reprocessing
— determination for burnup calculations on thorium-containing fuels
— determination in aqueous fission product solutions, in-line (M.C.G.)

11887 (GULF-GA-A-12285) FLUIDIZED-BED COMBUSTORS USED IN HTGR FUEL REPROCESSING. Baxter, B. J.; Brooks, L. H.; Hutton, A. E.; Spaeth, M. E.; Zimmerman, R. D. (Gulf General Atomic Co., San Diego, Calif.). Oct 1972. Contract AT-(04-3)-167. 17p. (CONF-721056-1). Dep. NTIS.

From third international conference on fluidized bed combustion; College Corner, OH (29 Oct 1972).

High-temperature gas-cooled reactors utilize graphite-base fuels. Fluidized-bed combustors are being employed successfully in the experimental reprocessing of these fuels. A general discussion of the reprocessing method is presented and two types of fluidized beds being used are described. (auth)

11888 EUROPEAN COOPERATION IN THE FIELD OF REPROCESSING OF IRRADIATED NUCLEAR FUELS. Zuehlke, Peter (United Reprocessors GmbH, Karlsruhe, Ger.). At. Strom; 18: No. 9-10, 128-31(1972). (In German).

In the field of reprocessing of nuclear fuels there is an outstanding discrepancy between the large installations that are available and the insignificant demand. Favorable reprocessing prices can be offered only by fully utilized large installations. As a result of an incentive given by Foratom for the coordination of reprocessing in Europe, the United Reprocessors GmbH was founded by the BNFL, the CEA, and the Kewa in which the utilization of the existing installations and further investment are coordinated and in which the sale of reprocessing and the related services are organized. (auth)

11889 METHOD AND EQUIPMENT FOR THE ELECTROREFINING OF PLUTONIUM. Long, J. L.; Schweikhardt, R. D. (to United States Atomic Energy Commission). German Patent 1,533,466. 27 Apr 1972. (In German).

The process for electrorefining of plutonium at a temperature between 700 and 830°C is characterized in that plutonium is placed in contact with a mixture consisting of equimolar amounts of NaCl and KCl and an additional 2.5 to 9.8 wt % $MgCl_2$ for the formation of an electrolyte and liquid melted plutonium. The melt is stirred for 30 to 120 minutes and finally subjected to conventional electrolysis. For the process a special electrorefining cell was developed with a casing containing a heatable vessel with a closable lid. (GF)

11890 ADSORPTION PROCESS FOR THE COMPLETE AND NON-DISSIPATIVE SEPARATION OF A GAS MIXTURE INTO ADSORBABLE AND NON-ADSORBABLE, IN PARTICULAR RADIOACTIVE COMPONENTS. Lepold, M. F.; Heinze, G.; Kaule, G.; Podschus, E. (to Bayer Aktiengesellschaft). U. S. Patent 3,703,797. 28 Nov 1972. Priority date 13 Sep 1968, Germany.

A process was developed for the complete separation of an adsorbable gas component A from another substantially nonadsorbable gas component B in at least two adsorption zones 1 and 2 arranged one behind the other, comprising the following steps: (a) in the first step the adsorption zone 1 is loaded until completely saturated with the component A; (b) in the second step the feed gas in the interstitial volume of adsorption zone 1 is displaced with pure component A from a storage means and the sweeping gas, optionally together with the feed gas is delivered to the partially unloaded zone 2; (c) in the third step the pure component A is liberated by heating of zone 1 and is delivered to a storage means. Thereafter the aforesaid steps are repeated however with interchanged functions of zones 1 and 2. This method can be applied to the processing of waste gases from the disintegration by combustion of irradiated nuclear fuel elements containing graphite. (auth)

ENGINEERING

Energy Conversion

Refer also to abstracts 11912, 11994, and 12202.

11891 (AD-746255) DEVELOPMENT OF FLAME-HEATED THERMIONIC DIODES. Final Report, October 30, 1961-April 1, 1972. Lazaridis, L. J.; Pantazelos, P. G.; Shefsiek, P. K. (Thermo Electron Engineering Corp., Waltham, Mass.). May 1972. Contract DA-36-039-SC-87341(E). 230p. (TE-4017-124-72; ECOM-87341-F). NTIS.

Work to develop a gasoline-fired thermionic power supply is reported. The work is divided into three phases: the development of a gasoline burner capable of providing the high temperature and high heat fluxes required by the thermionic converters; the development of a thermionic converter with the required power output, efficiency, weight and life; and the design of a power supply using the above two components and including power conditioning, controls and packaging. (auth)

11892 (AD-747661) INVESTIGATION OF A NONEQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR. Annual Report, August 1, 1971-July 31, 1972. Zauderer, Bert (General Electric Co., Philadelphia, Pa. Space Div.). 31 Jul 1972. Contract N00014-70-C-0321. 37p. NTIS.

The completion of a detailed study of electrode conduction led to the selection of thermionically emitting, cesiated tungsten as the most desirable cathode material for closed cycle, MHD generators. It was also found that with a high cesium ion flux at the cathode, electrode currents considerably higher than thermionic levels could be obtained. It was also shown that the cold aerodynamic boundary layer was a major contributor to the electrode losses. Measurements of the gas dynamic performance of the MHD generator under a wide range of load conditions showed good agreement with the MHD generator theory. For the first time anywhere, 8.5% heat to electric conversion was obtained in the MHD generator at 2100°K in cesium seeded neon. Based on the above results, a new MHD system consisting of a longer and larger MHD channel and a magnet which was more powerful than the previous one was constructed and installed in the shock tunnel facility. (GRA)

11893 (IAE-2043) STUDYING THE OUTPUT POWER AND CRYSTALLOGRAPHIC STRUCTURE OF MOLYBDENUM CATHODES OF THERMIONIC CONVERTERS. Kravchenko, Yu. Ya; Novgorodtsev, G. A.; Stolyarov, G. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 14p. (In Russian). INIS.

The output power of thermionic converters assembled with different types of Mo cathodes was determined. The crystallographic orientation of cathode surfaces was elucidated through the use of color reagents. Only a small portion of the surface effectively operated in the cases examined. The crystallographic structure was examined as a function of the thermal history and cathode geometry. (tr-auth)

11894 (IAE-2087) AN EXPERIMENTAL STATIONARY MGD (MAGNETOHYDRODYNAMIC)-ASSEMBLY OPERATING IN ACCORDANCE WITH THE RANKINE CYCLE (CONSTRUCTION AND TECHNOLOGICAL PROBLEMS). Velikhov, E. P.; Kareev, Yu. A.; Karpukhin, V. T.; Karasev, A. I.; Kol'chenko, A. I.; Lanis, V. A.; Muzychenko, A. D.; Nedospasov, A. V.; Panchenko, V. D. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

The construction and operating characteristics are described for a thermophysical loop, a MHD generating unit, an experimental magnetic system, all of which are capable of performing in a Rankine cycle on a Hg-Cs mixture. A number of technical problems in connection with materials of construction and the process of readying the loop for operation are discussed. (tr-auth)

11895 (JPRS-57915) INFLUENCE OF THE METHOD OF LIQUEFYING THE VAPOR PHASE ON THE FLOW CHARACTERISTICS OF THE ACCELERATOR OUTPUT OF A LIQUID-METAL MHD-CONVERTER. Kozlov, V. B.; Dzhamardzhashvili, V. A. Translated from Izv. Akad. Nauk SSSR, Energ. Transp.; No. 5, 90-95(1972). 10p. NTIS.

A thermodynamic analysis of several types of accelerators for liquid-metal MHD-converters is presented. (auth)

11896 (JPRS-57940-2) MAGNETOHYDRODYNAMIC METHOD OF PRODUCING ELECTRICAL ENERGY. PART II. Kirillin, V. A.; Sheindlin, A. E. (eds.). Translated from pp 180-347 of Magnitogidrodinamicheskii Method Polucheniya Elektroenergii, Energiya, Moscow, 1972. 208p. NTIS.

A collection of articles on magnetohydrodynamic electric energy generation is presented. The theory and calculation of flows in a MHD generator operating on an equilibrium plasma, experimental investigations of open-cycle MHD generators, investigations of the physical processes and diagnostics in open- and closed-cycle MHD generators, investigations of the basic equipment of MHD generators, investigations of circuits and cycles of power stations with MHD generators, liquid-metal MHD plants, and material for MHD generators are discussed. (auth)

11897 (N-72-25668) PROBE MEASUREMENTS OF A CESIUM PLASMA IN A SIMULATED THERMIONIC ENERGY CONVERTER. Shimada, K. (Jet Propulsion Lab., Pasadena, Calif.). 15 May 1972. Contract NAS7-100. 15p. (NASA-CR-126866; JPL-TM-33-551). NTIS.

Cesium-filled thermionic energy converters are considered as electrical energy sources in future spacecraft requiring tens to hundreds of kilowatts of electric power. The high operating temperatures necessary for a large specific power and high efficiency impose stringent constraints on the converter fabrication. The converter physics for reducing operating temperatures and cesium plasma losses are being studied to achieve high reliability without sacrificing the power performance of the converters. Various cesium parameters which affect the converter performance are electron temperatures, plasma ion densities, and electric potential profiles. These were investigated using a Langmuir probe in a simulated converter. The parameters were measured in different cesium discharge modes. (STAR)

11898 LIQUID METAL ELECTRICITY GENERATORS. Bidard, R. (Compagnie Electro-Mechanique, Paris). Energ. Nucl. (Paris); 14: No. 4, 307-24(Jul 1972). (In French).

The advantages of liquid metal MHD generators are discussed. The behavior of such generators compared to that of conventional plasma generators is examined. The different heat sources are studied. A table is presented of all the possible variants of liquid metal MHD cycles (with or without phase separation during the cycle) having one or several components, one of which may or may not be condensable. Many different combinations are available. A description is given of three combinations which appear to be interesting for the following systems: ejecting condenser system operating with K, Li-Cs system, and Na-He (or A) system with two phase MHD generators (emulsion generator). The irreversibilities encountered using these three solutions are discussed. It is concluded that the last solution shows the greatest promise, such a system being capable of a thermal efficiency in excess of 50%. (France)

11899 MHD ELECTRICAL POWER GENERATION: 1972 STATUS REPORT. At. Energy Rev.; 10: No. 3, 302-77(Sep 1972).

The extensive research, development and construction programs conducted in many countries have shown that the MHD method of power conversion offers great possibilities for power generation: increased efficiency, minimum cost per installed kilowatt, and the promise of substantial reduction of harmful effects on the environment. MHD power generation is entering a new stage of development. The first large pilot plant incorporating all the components of future MHD electrical power stations was designed for an MHD generator power of 25 MW(e) and went into operation in the Soviet Union in March 1971. The Status Report reviews the principal theoretical, experimental and developmental results obtained in various countries and gives current views on the prospects of MHD power generation in different areas of possible application. The central part of the Report consists of three sections corresponding to the three basic types of MHD plants: open-cycle plants, closed-cycle plants with a plasma MHD generator, and closed-cycle plants with a liquid-metal MHD generator. A further section is devoted to superconducting magnetic systems. A survey is given of the national MHD development programs of some leading countries. It emphasizes that major efforts are being made in this field and reviews activities planned for the next few years. In conclusion, various problems still awaiting solution are outlined. References to 144 papers of interest are included. (auth)

11900 TWO STUDIES IN MAGNETOHYDRODYNAMICS: CONCERNING INSTABILITY AND SOLITARY WAVES. Wang, C. Y. Ann Arbor, MI; Univ. of Michigan (1972). 124p. University Microfilms Order No. 72-29,234.

Thesis.

The instability due to a discontinuity in conductivity and solitary waves of finite amplitude and permanent form in the conducting

fluid are investigated. The stability of a viscous, incompressible, conducting fluid with finite electric conductivity is considered. The chief purpose of this study is to demonstrate that a discontinuity in electric conductivity can cause instability under the combined action of an electric current and a superimposed magnetic field normal to it. A horizontal layer of fluid with a free surface is set in motion by the horizontal electric current and a vertically imposed magnetic field. An eigenvalue problem governing the stability of the fluid is formulated for infinitesimal disturbances. The method of regular perturbation by expanding the eigenfunctions and eigenvalues in power series of the wave number α is adopted to solve the Orr–Sommerfeld equation and the magnetic diffusion equations. The eigenvalues obtained are used to determine the stability or instability of the flow. In addition to the well-known stabilization effect of the electromagnetic field through the magneto dissipation, a destabilization effect of the field has been discovered. Thus, if the electromagnetic effects are sufficient to overcome the stabilizing effect of gravity, the flow is unstable. Although only the extreme case of a conducting fluid with a free surface is considered, the instability is probably present also in a fluid with continuous stratification in conductivity. In the second part of the work, solitary waves of finite amplitude and permanent form in an inviscid, incompressible conducting fluid between two concentric cylinders are investigated. The solitary waves found correspond to the solitary water waves studied by Korteweg and deVries. These waves are due to the nonuniformity of radial electromagnetic body forces in the fluid. Equations governing the displacement of stream surface subjected to axisymmetric disturbances are solved by a perturbation method. Long waves with infinitesimal amplitude are obtained from the first-order approximation while solitary wave solutions are obtained from the second-order approximation. Two simple cases of solitary waves in the conducting fluid between the annular region of two concentric cylinders are presented. The first case for a circular magnetic field; the second case is for circular and vertical magnetic fields. It is found that a line current passing along the axis of the cylinders is necessary in order to generate wave motion. Both cases are investigated in detail and results are presented. (Diss. Abstr. Int., B)

11901 PROSPECTS FOR SYNTHETIC FUELS IN THE UK. Day, G. V. (Programmes Analysis Unit, Chilton, Eng.). Futures; 4: No. 4, 331-43(Dec 1972).

An answer is given to the question: "What happens when oil and natural gas production start to decline?" Forecasts of the world production and demand for oil and gas are reviewed briefly and it is concluded that large scale production of synthetic oil from coal and oil shale in particular will have to start by about the year 2000, and that energy intensive processes for the production of fuels such as methanol and hydrogen from non-fossil sources will have to start on a large scale during the period 2000 to 2030. (auth)

11902 ELECTRICAL CONDUCTIVITY OF LIQUID METAL TWO-PHASE MIXTURE IN BUBBLY AND SLUG FLOW REGIME. Tanatugu, N.; Fujii-e, Y.; Suita, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 12, 753-5(Dec 1972).

Research on liquid metal magnetohydrodynamic generators is reported in which the electric conductivity of a two-phase mixture in bubbly and slug flow regimes in its passage through a rectangular cross section channel of large aspect ratio (15 : 1) is calculated and measured. Experimental results show that the electric conductivity ratio of liquid metal-gas two-phase mixture agrees well with Maxwell's theoretical value in bubbly flow regime, and decreases sharply upon transition from bubbly to slug flow regime. The electrical conductivity ratio of a weak electrolyte-gas two-phase mixture agrees well with Maxwell's theoretical value or $(1 - \alpha)$ up to considerably higher void fractions, and differs from that for liquid metal-gas two-phase flow mixtures. (JRD)

11903 RADIONUCLIDE-POWERED THERMOELECTRIC GENERATORS. Myatt, J.; Penn, A. W.; Poole, M. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Kerntechnik; 14: No. 9, 391-4(Sep 1972).

As a result of the Radioisotope Powered Prolonged Life Equipment (RIPPLE) program started in Britain in 1963 to generate electricity in the 100 mW to 50 W range, preliminary surveys were made of terrestrial applications where long life with unattended operation could be useful. Applications identified included marine navigational aids, v.h.f. and microwave land repeaters, submarine cable repeaters, remote weather stations, underwater sonar beacons, oceanographic equipment and, in the field of medicine, the heart pacemaker. Radionuclide-powered thermoelectric generators suited to these applications which has been constructed and tested at the United Kingdom Atomic Energy Authority's research center at Harwell are discussed. (auth)

11904 TOPLIVNO-ENERGETICHESKIE RESURSY I ENERGETIKA INDII. (Fuel Energy Reserves and Power in India). Glazachev, M. V. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Vostochnoi Literatury (1971). 184p.

The aggregate of all branches of the fuel and power economy of India and its potential reserves of energy are explored. Estimates are offered for coal and lignite, petroleum and natural gas, raw material for nuclear power plants, hydroelectric reserves, and non-commercial forms of fuel (straw, dried manure, bagasse, etc.). The current status of the various industries based on these fuel sources (coke production, petroleum processing, etc.) is reviewed. One chapter is devoted to the consumption of power by India in the industrial sector, the transport sector, and the population sector. (100 references) (KSW)

11905 EFFECT OF THE TEMPERATURE OF THE ANODE ON THE VOLT–AMPERE CHARACTERISTICS OF A THERMOELECTRONIC CONVERTER UNDER ARCING CONDITIONS. Maksimov, V. A.; Titkov, A. S. High Temp. (USSR) (Engl. Transl.); 10: No. 2, 363-364(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 416-417 (1972).

A variety of experimental results in the effect of the anode temperature on the operation of a thermoelectronic converter under arcing conditions is examined. Investigations have continued on the operation of a thermoelectronic converter previously performed by Maksimov and Titkov. Measurements were made of the effective heat of condensation of the electrons, not for one definite current, but in conjunction with segments of the volt-ampere characteristics and, in addition, the region of anode temperatures (900 to 1300°K) was broadened toward the side of the higher values. From an accumulation of data, an expression for the effective heat of condensation of the electrons, q_c^*, is derived. Therefore, the most probable factor leading to a change of q_c^* with a change of T_a is the change in the work yield of the "virtual" anode and, from the experimental data it follows that, over the whole range of values of T_a, the behavior of the volt-ampere characteristics can be completely explained by the change in the value of the work yield of the "virtual" anode. It is stated, though, that the existence of a "virtual" anode in the development of arcing conditions is not a rigorously proven fact. (JCW)

11906 EXPERIMENTAL DETERMINATION OF THE CONDUCTIVITY OF A PLASMA IN THE CHANNEL OF A MAGNETOHYDRODYNAMIC GENERATOR. Gaponov, I. M.; Nefedov, A. P. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 2, 365-366(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 418-419 (1972).

The conductivity of the stream of plasma exerts a decisive effect on the operation of a MHD generator as an energy converter, since the conductivity determines the specific takeoff of power from the generator. Simultaneous measurements were made of the conductivity and the temperature of a plasma in the same cross section of the channel of the MHD generator of a U-02 unit. The conductivity of the plasma was measured from the change in the Q factor of the loop (Olson and Lary, Electrodeless Plasma Conductivity Probe Apparatus, RSI, 33, No. 12, 1330 (1962)), and the temperature was measured using the method of the reversal of the spectral lines. The system of measuring the conductivity consisted of a pickup and an electronic unit for recording the signal. A description of the measurements and results are given. The first results of measurements of the conductivity of a plasma consisting of combustion products were given by Vasil'eva, et al., Fifth International Conference on MHD Electrical Generation, Vol. 1, Munich (1971). Data were obtained for a broader temperature range and is published in this paper. Results show a 15% error in determination of conductivity and 1.2% in temperature determination. (JCW)

11907 ALTERNATIVES TO NUCLEAR ENERGY. Heronemus, W. E. (Univ. of Massachusetts, Amherst). Catal. Environ. Qual.; 2: No. 3, 21-2(1972).

The feasibility of using solar energy and wind power created by solar energy as a non-polluting alternative to nuclear energy for electric power production is discussed. (LCL)

11908 SOLAR SEA POWER. Zener, Clarence (Carnegie-Mellon Univ., Pittsburgh). Phys. Today; 26: No. 1, 48-53(Jan 1973).

A system for producing electric power from heat engines operating in tropical oceans is described. The energy required would be realized from the temperature differential between upper and lower water levels. (TFD)

Facilities and Equipment

Refer also to abstracts 12466, 13976, 14013, 14014, 14016, and 14284.

11909 (CTC-INF-1051) STUDY OF THE EFFECT OF NEGATIVE-SEQUENCE TORQUES ON INDUCTION MOTOR STABILITY. Layman, L. R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 29 Dec 1972. Contract W-7405-eng-26. 97p. Dep. NTIS.

A study was performed to determine the error introduced into double-line-to-ground fault transient-stability calculations by neglecting negative-sequence torques in induction motors and to compare the relative effect of three-phase, double-line-to-ground, line-to-line, and single-line-to-ground faults on induction motor stability. The studies were made on the power system associated with the U. S. Atomic Energy Commission's gaseous diffusion plant located at Oak Ridge, Tennessee. Digital computer programs were used to calculate equivalent induction motor and transformer impedances, power flows in electrical networks, and the dynamic behavior of a power system during transient conditions. The procedure for making a transient-stability study on a power system using these computer programs is described. The effect of negative-sequence torques on induction motor stability was determined by making transient-stability studies in which the calculations of negative-sequence torques were included in the model used for the induction motor and then repeating the studies with the negative-sequence torques neglected. Four transient-stability studies were made with three-phase, double-line-to-ground, line-to-line, and single-line-to-ground faults to determine the relative transient response of induction motors to the four types of faults. System bus voltages and induction motor slips are plotted as functions of time to aid in interpreting the results of the transient-stability calculations. (auth)

11910 EQUIPMENT USED IN INJECTION MOLDING OF A PHOTOGRAPHIC FILM CANISTER (16 Dec 1968) (Engineering Materials). (Los Alamos Scientific Lab., NM). (CAPE-2305). 2 drawings.

The design of an injection mold for a photographic film canister for production is presented. The cylindrical canister required exceptional impact strength, light and water tightness, an integrally antistatic material, and a tight-locking, reusable lid that could be locked using a quarter turn. An antistatic grade of polypropylene resin was used. (auth)

11911 EXTERNALLY PRESSURIZED BEARINGS. Conference Held at London, England, November 17–18, 1971. London; Institution of Mechanical Engineers (1972). 477p. (CONF-711147).

A compilation of 26 papers given at the conference is presented. An index of authors and participants is included along with a subject index. (J.R.D.)

11912 COOLING TOWERS. Olds, F. C. Power Eng.; 76: No. 12, 30-7 (Dec 1972).

The role of cooling towers in the dissipation of waste heat from power plants on a large scale is discussed. The complexity which towers add to the task of generating electricity is considered. Questions concerning design, operation, and costs of cooling towers are examined. (T.F.D.)

11913 IMPROVEMENTS IN PRESSURE VESSEL ASSEMBLIES. Pigott, A. E.; Paraty, L. E.; Tomkins, B. (to United Kingdom Atomic Energy Authority). British Patent 1,292,641. 11 Oct 1972. Filed 17 Mar 1969.

Reference is made to pressure vessel assemblies comprising inner and outer concentric pressure vessels with an annular interspace between the vessels containing pressurized liquid, so as to apply a compressive hoop stress on the inner vessel. This results in subjection of the inner vessel to compressive strains having the effect of increasing the fatigue life of the vessel under internal pressure cycling conditions. Sealing means must be provided between the inner and outer vessels at the ends of the interspace. In the arrangement described fluid in the inner vessel is independently pressurized, and the ends of the interspace between the inner and outer vessels are closed by sealing means allowing radial expansion of the inner vessel under the application of fluid pressure in the inner vessel, without giving rise to stressing of the outer vessel by radial expansion of the inner vessel. Constructional details are given for the various components of the assembly. (UK)

11914 EVOLUTION OF PERMANENT MAGNETS MADE FROM RARE-EARTHS COMPOUNDS. Cedighian, Suren Electrotehnica (Bucharest); 20: No. 9, 351-2 (Sep 1072). (In Rumanian).

Progress has been achieved in rare-earth magnet manufacture, partially substituting misch metal for samarium, without affecting the magnetic energy; in cast magnets a rise in energy of about 20% was observed. These results have led to a simplification of elaboration technology and reduced costs. Rare-earth magnets have gone into serial production. (auth)

11915 EVALUATION OF AN EXPLODED-WIRE AEROSOL GENERATOR FOR USE IN INHALATION STUDIES. Phalen, R. F. (Univ. of Rochester, NY). J. Aerosol Sci.; 3: No. 5, 395-406 (Sep 1972).

An exploded wire aerosol generator was evaluated using test aerosols derived from silver wires and results were compared with existing published information on exploded wire particles. Aerosol properties relevant to inhalation studies were emphasized. Primary particles were spherical, metallic, and distributed nearly lognormally by volume (geometric standard deviation about 1.5) with count median diameters between 0.05 and 0.008 μm. The primary particle size decreased as the explosion energy per unit mass of wire was increased. Primary particles rapidly formed agglomerates of up to hundreds of spherical units but an air blast aimed at and synchronized with the wire explosion was successful in reducing agglomeration. Agglomerate aerosols with submicron aerodynamic diameters were produced by rapidly diluting the explosion zone after the air blast. Agglomerates of 0.026 μm count median diameter primary particles had measured specific surfaces of 16.4 m^2/g and solubility rate constants of 10 $\mu g/cm^2$ per day in a lung fluid simulant containing protein. The relevance of exploded wire agglomerates to inhalation studies is briefly discussed. (auth)

11916 FLUIDIZED BED COATING APPARATUS. Flamm, H. J. (to Commission of the European Communities). German Patent 1,801,396. 16 Jun 1972. (In German).

Fluidized bed equipment to coat grain-formed materials or objects by means of pyrolysis of a flow medium is described. The apparatus consists of treatment equipment and an injecting unit, the flow medium with inlets coaxially placed to one another for the fluidized bed, and the treatment flow medium. The proposed special construction assured a high degree of concentricity of the various coaxial flow which allows an even distribution of gas. (GF)

Heat Transfer and Fluid Flow

Refer also to abstracts 11895, 12268, 14321, and 14322.

11917 (CEA-CONF-2080) USE OF POROUS COATINGS ON THE WALLS OF CONDENSERS AND EVAPORATORS OF THERMAL MACHINES. Moracchioli, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 2p. (In French). (CONF-720463-1). Dep. NTIS (U. S. Sales Only).

From Conference of the French society of thermists; Toulouse, France (27 Apr 1972).

A study of porous walls with capillary properties and open porosity was undertaken with the purpose of developing small autonomous energy converters with omnidirectional functioning based on the Rankine thermodynamic cycle with phase change. This cycle imposes the position stabilization of the liquid-vapor interface at the level of the diphase exchangers. The functioning of the generator with porous walls is calculated and the functioning of the exchange surface is determined. (J.S.R.)

11918 (CEA-R-4302) MEASUREMENTS WITH A MICRO-THERMOCOUPLE OF THE LOCAL VOID FRACTION AND THE TEMPERATURES OF THE LIQUID AND VAPOR IN TWO-PHASE FLOW WITH PHASE CHANGE. Delhaye, J. M.; Semeria, R.; Flamand, J. C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1972. 52p. (In French). Dep. NTIS (U. S. Sales Only).

A microthermocouple is described which indicates not only the temperature but the phase actually surrounding its hot junction. The resulting signals are statistically processed by a multichannel analyser which gives the local temperature histograms of the liquid and of the vapor. Encouraging results have been obtained during the study of water pool-boiling, local boiling in forced convection and flashing flow. This technique can be used only in conducting liquids. Nevertheless, it is possible to get the same information in a non-conducting liquid by stating some hypotheses. (auth)

11919 (CONF-720849-1) ANTICIPATION OF OPERATING PROBLEMS IN THE DESIGN OF HEAT TRANSFER EQUIPMENT. Gardner, K. A. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 1972. Contract AT(04-3)-700. 26p. Dep. NTIS.

From Recent developments in heat exchangers seminar; Trogir, Yugoslavia (30 Aug 1972).

Results of studies of deficiencies in heat exchanger operation are discussed in which optimum design aimed at minimizing these deficiencies is emphasized. Discussions are included on aspects of heat transfer and pressure loss ratings, and causes of pressure vessel failure. (J.R.D.)

11920 (K–1832) EXPERIMENTAL DETERMINATION OF THE PERFORMANCE CHARACTERISTICS OF EIGHT COMPACT HEAT TRANSFER SURFACES. Cox, B.; Jallouk, P. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 27 Dec 1972. Contract W-7405-eng-26. 97p. Dep. NTIS.

Heat transfer and flow friction characteristics were determined experimentally for eight heat exchanger geometries. All of the exchangers were compact and represented a variety of gas-side surfaces: brazed aluminium plate-fin sandwiches, plate-finned tubes, plates with integral serrated fins, tubes with integral serrated fins, and tubes with integral smooth helical fins. Data were taken with heat transfer from air to water. General methods are presented for reducing the data to a dimensionless form and for comparing the performances of different surfaces. (auth)

11921 (LA–4985) TIME-DEPENDENT SOLUTION TO INTERSTITIAL DIFFUSION IN A TEMPERATURE GRADIENT. Lee, C. E.; Wallace, T. C. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 29p. Dep. NTIS.

The feasibility of the simultaneous determination of the chemical interdiffusion coefficient and the effective heat of transport of interstitial compounds, such as refractory carbides and hydrides is demonstrated. A mathematical model is constructed, based on the thermodynamics of irreversible processes, which represents the time-dependent interstitial diffusion process in a temperature gradient. The model is linearized and solved analytically. The analytical solution of this model is compared with a numerical difference solution method of attacking the original problem. It was found that the linearized analytical solution agrees with the numerical difference solution to 1% in most cases and 3% in the worst case. The sensitivity of the analytical solution to parameter variations is sufficient for least-squares evaluations of experiments. The analytical solution method is comparably superior to the numerical difference solution method in terms of accuracy and speed when applied to experimental data. (auth)

11922 (RD/B/M–1956) RESULTS OF HEAT TRANSFER AND PRESSURE DROP TESTS IN THE B.N.L. AIR RIGS ON SURFACES ROUGHENED BY TRANSVERSE RIBS. Warburton, C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct 1972. 16p. Dep. NTIS (U. S. Sales Only).

The accumulated heat transfer data from a single pin quick test facility for surfaces artificially roughened by transverse ribs have been reprocessed using improved analysis and transformation techniques. The results for the sixty surfaces are presented in tabular form and give the transformed friction factor and Stanton numbers for a range of Reynolds numbers along with the geometry of each surface. Under the present experimental conditions the best surface shows an increase of 111% in thermal performance ratio when compared with a smooth surface. A typical AGR surface only gives a 48% improvement over a smooth one. (auth)

11923 (RD/B/N–2404) INVESTIGATION OF FLOW PARAMETERS FOR A SERIES OF CONCENTRIC ROUGH PIN AND SMOOTH CHANNEL ASSEMBLIES. Lee, C. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sep 1972. 32p. Dep. NTIS (U. S. Sales Only).

Isothermal pressure drop and velocity measurements have been made using a number of rough pins mounted centrally in a series of smooth channels. The surface roughness of the pins consists of transverse square ribs with a pitch to height ratio of 7.2. Friction factors transformed to the true surface of no shear are presented and correlated with the flow passage geometry. This shows that although e/de_1 is the dominant parameter d/de_1 can have a significant effect on friction factor at constant e/de_1. Both parameters are therefore important in assessing the surface performance from single pin tests. The rough surface velocity profiles have been fitted to an equation of the form $u_1^+ = A \ln(y_1/e) + B$, and A and B are shown to vary with rib Reynolds number over the range 20 to 1000. (auth)

11924 (WARD–5836) HEAT AND MASS TRANSFER IN POROUS DEPOSITS WITH BOILING. Cohen, Paul (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). 1972. 54p. (CONF-721106–4).

From 65th annual meeting of the American Institute of Chemical Engineers; New York, NY (26 Nov 1972).

The concentration of solutes in porous deposits at heat transfer surfaces with boiling is considered on the basis of a number of models of the heat transfer process. Equations describing the concentration are derived, allowing for solute volatility and precipitation, and are compared with experimental data applicable to water cooled power reactors. (auth)

11925 SYNTHESIS METHOD FOR SOLVING THE HEAT-CONDUCTION PROBLEM OF A FINITE CYLINDER WITH VARIABLE SURFACE HEAT TRANSFER. Meier, S.; Ullrich, R.; Johannsen, K. (Technical Univ., Berlin). Nucl. Eng. Des.; 22: No. 2, 233-43(1972).

The synthesis method, originally developed for solving neutron group diffusion problems, is applied to determine the three-dimensional temperature fields in a finite heat-generating cylinder due to heat transfer variation over its surface. Using only three trial functions in the synthesis, a number of sample results for a two-dimensional case are presented and compared to corresponding solutions obtained by point-matching technique. Conclusions are drawn as to the applicability of the method from the point of view of accuracy as well as digital computer requirements. (auth)

11926 FINITE ELEMENT SOLUTION OF THE THREE-DIMENSIONAL FLOW PROBLEM AND OF REYNOLD'S EQUATION FOR INCOMPRESSIBLE AND COMPRESSIBLE FLUIDS. Crastan, V.; Devos, J. E. (Schweizerische Elektrizitaets- und Verkehrsgesellschaft, Basel). Nucl. Eng. Des.; 22: No. 2, 225-32(1972).

The theoretical basis for application of finite element techniques to a general three-dimensional flow problem is presented. The finite element solution of Reynolds equation for incompressible and compressible fluids has been programmed and applied to the particular case of gas lubricated Rayleigh step journal bearing. The calculated pressure distribution and the load and attitude angle are given for different compressibility numbers and journal lengths. The results are compared with those obtained with simplifying assumptions. (auth)

11927 FLOW-INDUCED IN-PLANE INSTABILITIES OF CURVED PIPES. Chen, S. S. (Argonne National Lab., IL). Nucl. Eng. Des.; 23: No. 1, 29-38(1972).

The equation of motion of curved pipes conveying fluid is derived from Hamilton's principle. Depending on the end conditions, the system may be conservative or nonconservative. It is shown that when the flow velocity exceeds a certain value, the conservative system becomes subject to buckling-type instability and the nonconservative system becomes subject to fluttering-type and buckling-type instabilities. The critical flow velocity at which the pipe loses stability has been computed for four end conditions. (auth)

11928 APPROXIMATE SOLUTION FOR THE THERMAL INFLUX AT DUCT ENTRANCE WITH SLUG FLOW IN A HEXAGONAL DUCT WITH CONSTANT WALL HEAT FLUX. Nagel, Horst; Wolf, Lothar (Technical Univ., Berlin). Nucl. Eng. Des.; 23: No. 1, 10-28(1972).

Results are presented on studies of approximate slug flow Nusselt numbers in the thermal entrance region of ducts with regular hexagonal cross section in case of constant wall heat flux. The complex variable method was applied. In addition, the asymptotic wall temperature distribution and the asymptotic Nusselt number have been determined which are in good agreement with those found in the literature. For comparison, the same problems in case of the round tube have been solved with the same methods of solution. The advantage of the methods of solution used is that it is valid for any shape whose mapping function is known. (auth)

11929 STUDY ON THE HEAT TRANSFER IN TWO-PHASE CHANNEL FLOW BOILING. 1. FLOW PATTERN IN BOILING CHANNEL. Sato, T. (Kyoto Univ.); Minamiyama, T.; Yanai, M.; Tokura, T. Nippon Kikai Gakkai Ronbunshu; 38: No. 310, 1478-86(Jun 1972). (In Japanese).

Studies of the flow pattern of two-phase flow in a channel in which boiling occurs are discussed. A system of circulation and test equipment are schematically illustrated. Measurements of the flow patterns were performed with photographs taken with a 35 mm camera and a 16 mm high-speed camera. Experiments were performed at steady state with definite thermal load, flow rate, and inlet temperature. The patterns observed with the cameras were classified into several categories, i.e., bubble flow, slug flow, slug annular flow, annular flow, and bubbly annular flow. Classification was performed according to voids, pressure, differential pressure, and variation of voids in the course of time. Relation of the flow rate and dryness is shown. Effects of thermal loading, heating length, voids, dryness, flow rate, and diameter of the channel on the transition of the flow pattern were investigated. (Japan)

11930 STUDY ON THE HEAT TRANSFER IN TWO-PHASE CHANNEL FLOW BOILING. 2. HEAT TRANSFER IN NUCLEATE BOILING REGION. Sato, T. (Kyoto Univ.); Minamiyama, T.; Yanai, M.; Tokura, T.; Ito, Y. Nippon Kikai Gakkai Ronbunshu; 38: No. 310, 1487-94(Jun 1972). (In Japanese).

Studies of boiling heat transfer in two-phase flow within channels were performed by measuring heat conductivity and observing the

flow patterns. Experimental apparatus and methods were similar to those explained in a previous report, and measurement was carried out simultaneously with the observation of flow patterns. The heat conductivity was obtained from the temperature Tw of the heat transfer surface and the temperature Tb of fluid. Factors which affect the heat conductivity were investigated. Thermal load, flow rate, and dryness were studied. Generally, the heat conductivity changed from the nucleating boiling region to force the convection region as the flow changed from bubbly flow to annular flow. Empirical formulas for the heat conductivity were obtained as functions of flow speed, convection thermal load, and the thermal load in nucleating boiling region. It was concluded that the heat conductivity increased with the increasing dryness slowly at first and suddenly later. The point of change of the heat conductivity was in agreement with the boundary of flow pattern. (Japan)

Materials Testing

Refer also to abstract 14229.

11931 (DUN-8056) SETUP AND ADJUSTMENT PROCEDURES FOR THE NON-DESTRUCTIVE TESTERS N FUELS SECTION. (Douglas United Nuclear, Inc., Richland, Wash.). 25 Sep 1972. 23p. Dep. NTIS.

Procedures for the use of nondestructive test equipment in testing N Reactor fuels are summarized. Procedures used for testing cap-to-core bonds, cap-to-clad bonds, clad-to-core bonds, and clad thickness are described. (J.R.D.)

11932 (RISO-272) METHODS OF FABRICATION AND MEASUREMENT OF ARTIFICIAL DEFECTS AS CALIBRATION STANDARDS FOR ULTRASONIC INSPECTION OF THIN-WALLED TUBING. Domanus, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sep 1972. 24p. Dep. NTIS (U. S. Sales Only).

Information was collected on standards and reports of research work dealing with the problems of artificial defects for calibration of ultrasonic equipment used for the quality inspection of thin-walled tubes. Conclusions are drawn about the choice of the best method for producing and measuring artificial defects. (auth)

11933 (RISO-273) ARTIFICIAL DEFECTS USED AT RISOE AS CALIBRATION STANDARDS FOR ULTRASONIC INSPECTION OF THIN-WALLED TUBING. Domanus, J.; Nielsen, N. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sep 1972. 24p. Dep. NTIS (U. S. Sales Only).

Artificial defects produced in Zircaloy cladding tubes at Risø are described. They were used at the Danish Welding Institute for calibration of the ultrasonic equipment. The shape and dimensions of artificial defects were measured with the light section microscope, and after calibration measurements with the ultrasonic apparatus the test tubes were sectioned and the shape and dimensions of artificial defects were again measured with a metallographic microscope. The results of all those measurements are compared and evaluated. Conclusions are drawn about the choice of the best method for producing and measuring artificial defects and about the necessity for further knowledge of the ultrasound field and shape of defects in order to establish a correct calibration procedure. (auth)

11934 AUTORADIOGRAPHIC INVESTIGATION OF THE MOVEMENT AND DISTRIBUTION OF RADIOACTIVE ISOTOPES IN POWDER METALLURGIC WOLFRAM. Bartha, L. (Research Inst. for Technical Physics, Budapest). Radioisotopy; 13: No. 3, 617-23(1972). (In German).

The large crystal structure of tungsten in glow filaments which gives the filament its mechanical strength at high temperature, is achieved by the joint effect of small quantities of K, Si, and Al. The autoradiograms produced on W-rods after diffusion of ^{185}W reveal that this large crystal structure of the sintered W-rod is observed only in those cases where micropores, due probably to the presence of impurities, develop. The presence of these pores can also be visualized by diffusion of the isotope ^{204}Tl. Under appropriate conditions, such as in the use of very thin diffusion sources and relatively low glow temperatures, the grain boundary diffusion, described by Suzuoka, can be observed in the autoradiogram. (auth)

11935 LIMIT LOADS OF VARIABLE THICKNESS CIRCULAR PLATES IN BENDING. Haydl, H. M.; Sherbourne, A. N. (Univ. of Waterloo, Ont.). Nucl. Eng. Des.; 22: No. 2, 296-300(1972).

The results of an investigation of rigid-plastic collapse of simply supported circular plates of variable thickness are presented. The plates are loaded with a uniformly distributed transverse pressure and the material is assumed to yield according to the von Mises criterion. Numerical results for collapse loads and stress fields are given in graphs and the solution for the resulting velocity fields is indicated. (auth)

11936 LOCALIZED LOADS APPLIED TO TORISPHERICAL SHELLS. Gwaltney, R. C. (Oak Ridge National Lab., TN). Nucl. Eng. Des.; 23, No. 1, 53-85(1972).

Torispherical shells are frequently employed as end closures for cylindrical shells. Such structures consist of a spherical cap joined to a toroidal segment, which is joined in turn to a cylindrical shell. In some cases, nozzles are attached to the torispherical shell. Solutions for spherical and cylindrical shells are known and approximate solutions for the toroidal shells are known. Analyses were derived to determine stresses in a torispherical shell which is attached to a cylindrical shell and which has a radial nozzle attached at its apex. The loadings considered were internal pressure, axial thrust applied to the nozzle, and a bending moment applied to the nozzle. A particular solution was developed for the bending analysis which had no limitations such as those placed on the earlier approximate solutions. Comparisons between the developed analyses and experimental data from two models tested under internal pressure show excellent agreement. Since the analyses for external loads are very similar to that for internal pressure, it can be assumed that the other analyses are correct also. The buckling of torispherical shells under internal pressure was studied by comparisons between calculated results and results from an experimental model that buckled. Results indicated that the structure failed by plastic collapse since the maximum stress was very close to the yield stress of the model material. (auth)

11937 ULTRASONIC FLAW DETECTION AS APPLIED TO CAST LEAD COMPONENTS. Dolgii, A. A.; Volkov, A. S.; Starostin, A. P.; Klimkin, G. P. Sov. J. Nondestruct. Test. (Engl. Transl.); 8: No. 1, 117-18(1972).

Translated from Defektoskopiya; 8: No. 1, 137-9(1972).

A study of the physical properties of lead and a preliminary laboratory examination indicated the possibility of using ultrasonic vibrations for detecting flaws in cast lead components. The suggested method of quality control in lead casting gives reliable information on defects, does not require highly skilled operators, and is applicable under production conditions used for the assembly and production of key components. (TFD)

11938 ELASTO-PLASTIC ANALYSIS OF THREE-DIMENSIONAL STRUCTURES USING THE ISOPARAMETRIC ELEMENT. Gupta, A. K. (Sargent and Lundy Engineers, Chicago); Mohraz, Bijan; Schnobrich, W. C. Nucl. Eng. Des.; 22: No. 2, 305-17 (1972).

A method for elasto-plastic analysis of three-dimensional structures is presented. The finite element method, implemented by a three-dimensional isoparametric element is used in the study. An "initial" stress approach is employed in the range of plastic behavior. Two numerical examples, an infinitely long hollow circular cylinder under a uniform internal pressure, and a simply supported beam subjected to a uniform lateral load are presented in order to illustrate the applicability of the proposed method. In the case of the cylinder, excellent agreement is obtained between the results from the proposed method and those from the existing solution. For the beam, the results from the proposed method are not in as good an agreement with the existing solution as those for the cylinder. The discrepancy is due to a "loss" in stresses in critical regions, which does not allow the plastification to penetrate rapidly enough into the depth. Suggestions for improvement are discussed. (auth)

11939 THREE-DIMENSIONAL ISOPARAMETRIC ELEMENT IN CURVILINEAR COORDINATES. Gupta, A. K. (Sargent and Lundy Engineers, Chicago); Mohraz, Bijan. Nucl. Eng. Des.; 22: No. 2, 301-4(1972).

The formulation of the stiffness matrix of an isoparametric element in curvilinear coordinates is presented. The use of curvilinear coordinates eliminates the necessity of introducing intermediate nodes for conforming to curved boundaries. The application of the method to cylindrical coordinates is illustrated by comparing the results for a cylindrical pressure vessel from this formulation with those obtained from the existing solutions. (auth)

11940 RADIOGRAPHIC IMAGE ENHANCEMENT BY DIGITAL COMPUTERS. Hunt, B. R.; Janney, D. H.; Zeigler, R. K. (Los Alamos Scientific Lab., NM). Mater. Eval.; 31: No. 1, 1-5(Jan 1973).

Enhancement of radiographic images has been under study at Los Alamos Scientific Laboratory (LASL) for the past three years. Results of the study demonstrated the feasibility of enhancing radiographs by digital computer and led to the purchase of a special system to be used for digitizing and reconstructing images. Some experience in the enhancement of radiographs and some of

the special problems of radiograph enhancement are discussed. Examples of enhancement are presented, using "before-and-after" pictures to illustrate the degree of improvement in picture quality. A brief discussion of some of the computing problems in image enhancement and a brief survey of the characteristics of LASL's new image processing system and a review of LASL's future plans in image processing are presented. (auth)

Nuclear Explosions

11941 (AD-744420) EARTHQUAKE RESISTANCE OF EARTH AND ROCK-FILL DAMS. REPORT 2. ANALYSIS OF RESPONSE OF RIFLE GAP DAM TO PROJECT RULISON UNDERGROUND NUCLEAR DETONATION. Ahlberg, J. E.; Fowler, J.; Heller, L. W. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Jun 1972. 139p. (AEWES-Misc-Paper-S-71-17-2). NTIS.

The motion of Rifle Gap Dam was measured in September 1969 during the Project RULISON underground nuclear explosion. The observed response was then compared with the response computed in a mathematical model. Observed and computed responses were similar. From the study it appears that the mathematical models used are applicable to the design and analysis of soil structures, at least for ground motion intensities comparable to those observed at Rifle Gap Dam. (auth)

11942 (AD-744773) NUCLEAR ELECTROMAGNETIC PULSE SIMULATION BY DIPOLE ANTENNA ARRAY TECHNIQUES. Technical Report, March 9-November 30, 1971. Klebers, Janis; Crowson, G. D. (Harry Diamond Labs., Washington, D. C.). Apr 1972. 37p. (HDL-TM-72-9). NTIS.

Time-domain dipole antenna array studies conducted at the Electromagnetic Effects Laboratory of the Harry Diamond Laboratories for application to large scale nuclear electromagnetic pulse (EMP) simulation are described. Analytically and experimentally derived EMP environments for a single-dipole antenna are compared with corresponding data for multiple element broadside and collinear dipole antenna arrays. The multiple-element concept is studied as a technique for eliminating the need for extremely high voltages in the single element-type nuclear EMP simulators by substituting the superimposed electromagnetic fields radiated by several lower voltage sources to obtain the equivalent EMP environment. Experimentally measured input impedances are compared with the results from classical antenna theory to determine the effects of mutual coupling between elements in the array configurations. (auth)

11943 (AD-745727) TRIN: COMPUTER PROGRAM TO CALCULATE TEMPERATURE DISTRIBUTIONS IN CIRCULAR AND RECTANGULAR SECTIONS EXPOSED TO THERMAL RADIATION FROM NUCLEAR WEAPON EXPLOSIONS. Dancer, D. M.; Wilson, D. M. (Naval Ordnance Lab., White Oak, Md.). 12 May 1972. 66p. (NOLTR-72-117). NTIS.

A computer program (TRIN) has been developed to calculate temperature distributions, in two or three dimensions, in bodies of rectangular or circular cross section exposed to transient thermal radiation heating from a nuclear weapon detonation. The cross section may be solid or hollow, the body may rotate or be stationary and the thermophysical properties can be arbitrary functions of local temperature. Capability of calculating distributions in three dimensions has been included to account for effects of heat sinks at the boundaries of the element. Solution of the heat conduction equation is accomplished by TRUMP, a well documented and verified computer program which is appended to TRIN as a subroutine. (GRA)

11944 (AD-746015) CODE FOR AIRCRAFT SURVIVABILITY, ANALYSIS: GAMMA AND NEUTRON EFFECTS. MaLaren, R. D. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 154p. (GNE/PH-72-8). NTIS.

Thesis.

A code is described that is used to predict neutron and gamma fluences (or doses), including neutron induced gammas, in an exponential atmosphere for burst altitudes between 7 and 100 kilometers. The problem was solved by using the diffusion equation, with separation of virgin and scattered particles, in a nonorthogonal coordinate system. The diffusion equation in this coordinate system was approximated by a nine point difference equation and the resulting matrix equation was solved by use of a block tridiagonal algorithm. The resulting computer code, in FORTRAN Extended, was written to calculate the survivability of up to 100 aircraft or space vehicles in addition to the calculation of fluences (doses). (auth)

11945 (AD-746020) CSSANE, A CODE FOR SYSTEM SURVIVABILITY ANALYSIS: NUCLEAR EFFECTS. DeRaad, R. G. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 118p. (GNE/PH-72-3). NTIS.

Thesis.

A computer code has been written in the FORTRAN EXTENDED language to determine aerospace system survivability to selected nuclear effects. A special case of survivability is treated in which system survival is based on a comparison of the sure-kill vulnerability level and the computed free field nuclear effects levels. The code consists of two functional parts. One part is the guiding program which conducts the survivability study; the other part consists of individual subroutines which evaluate free field nuclear environment levels. Subroutines have been included to evaluate the blast and thermal environments. (auth)

11946 (AD-746667) USER'S GUIDE TO THE SMAUG COMPUTER CODE. Technical Report, December 1970-February 1972. Murphy, H. M. Jr. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). May 1972. 74p. (AFWL-TR-72-3). NTIS.

SMAUG is a high-speed digital computer code, written in ANSI FORTRAN, that provides rapid estimates of the neutron and prompt gamma dose environment in the vicinity of a low to medium yield atmospheric nuclear detonation. SMAUG performs mass-integral scaling of ANISN discrete ordinates and SORS Monte Carlo results to obtain estimates of the neutron, prompt gamma, and secondary gamma spectra at user-selected receiver points. SMAUG is capable of computing altitudes and ranges at which selected dose values occur as well as isodose contour calculations. (auth)

11947 (AD-746958) NITROUS ACID FORMATION AND EFFECTS ON OPTICAL SYSTEMS IN THE 1 TO 15 MICRON REGION. Heimerl, J. M.; Niles, F. E. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Jun 1972. 25p. (BRL-MR-2201). NTIS.

Nitrous acid molecules have been shown to be formed from ion-molecule reactions rapidly enough to satisfy observed formation times following a sea-level nuclear burst. The possible implications of the polyatomic molecules as infrared emitters/absorbers are pointed out. (auth)

11948 (AWRE-O-49/72) SOME SEISMIC RESULTS FROM A WORLD WIDE SAMPLE OF LARGE UNDERGROUND EXPLOSIONS. Marshall, P. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct 1972. 100p. Dep. NTIS (U. S. Sales Only). UK 2.00 pound.

Short period seismic array data, together with long period data from standard stations, were analyzed to provide estimates of the location and yield of explosions in China, North Africa, the Soviet Union, and the USA. (auth)

11949 (JAB-99-93) STATISTICAL CORRELATION OF OBSERVED GROUND MOTION WITH LOW-RISE BUILDING COMPONENT DAMAGE: PROJECT RULISON. Scholl, R. E.; Farhoomand, I. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jan 1973. Contract AT(26-1)-99. 49p. Dep. NTIS.

The results of a statistical correlation study conducted using observed ground motion and structure damage data obtained from the RULISON underground nuclear explosion gas stimulation experiment are presented. Statistically derived relationships between pseudo absolute acceleration response spectrum values and damage ratios for the most frequently damaged components of low-rise buildings are given. Results show the relative vulnerability to damage of chimneys, interior walls, exterior walls, and foundations for various spectral intensities. The derived motion-damage relationships and other conclusions should be applicable to other locations where building characteristics are similar to those of the Project RULISON area. (auth)

11950 (PNE-RB-34) PROJECT RIO BLANCO, FEASIBILITY STUDY, PICEANCE BASIN, COLO. (CER Geonuclear Corp., Las Vegas, Nev.). 16 Apr 1970. 132p. Dep. NTIS.

The prospects for nuclear explosion stimulation of gas production in a portion of the Piceance Basin of Colorado were evaluated. Data from 38 wells were analyzed to determine: The optimum areas; amount of gas in place amenable to production stimulation in these areas; most desirable stratigraphic section; and average reservoir rock and fluid properties. Two generally favorable areas containing more than 40 billion standard cubic feet (BSCF) per section were delineated. Total gas in place in the most desirable stratigraphic section of these two areas is estimated to be 4.5 trillion cu ft. Maximum gas in place was calculated to be 100 BSCF per section. The Ft. Union Formation and upper portion of the Mesaverde Formation Mesaverde I, with a combined thickness of about 2,000 ft were found to provide the most desirable stratigraphic section. These intervals consist of alternating layers of shale and sandstone with a typical sandstone/shale ratio of approximately 0.30. Depths to the section's midpoint vary between 4,700 and 7,600 ft in the study area. The median porosity and

water saturation of the Ft. Union as calculated from logs were 13.5% and 60%, respectively. Medians for the underlying Mesaverde were found to be 10.5% and 60%. Permeabilities of 0.02 and 0.1 millidarcy (md) were calculated for the Mesaverde I and the Ft. Union, respectively. It is recommended that at least two wells be reentered and tested to establish valid in-situ gas permeabilities. Tandem explosions will be required to effectively fracture the combined section of Ft. Union and Mesaverde I rock. It is estimated that two tandem 30-kiloton (kt) explosions at depths of 6,000 ft and 7,000 ft will effectively fracture a 1,700-ft section of rock. A small diameter, fission explosive not requiring downhole refrigeration is recommended. A preliminary safety evaluation of the area was made, postulating a 60 kt combined maximum yield. No significant problems are evident from a containment or hydrologic standpoint. Structural response to ground motion will involve some damage, largely architectural, to a few nearby structures. Ground motion damage is estimated not to exceed $10,000. Depending on the site chosen, some precautionary measures with hydrocarbon wells and pipelines may be needed. The post shot deliverabilities for a number of different reservoir parameters were calculated using a radial flow model. The current "best guess" for a typical nuclear-stimulated well's reservoir performance is: 55 BSCF/sq mi for average gas in place; and a 20-year cumulative recovery of 24 BSCF/well with 1 well/sq mi. A number of the reservoir parameters should be evaluated prior to proceeding into the Project Definition phase, using the results of the recommended production tests. (auth)

11951 (PNE-WW-13) TECHNICAL STUDIES REPORT NUMBER TWO. Project Wagon Wheel. (El Paso Natural Gas Co., Tex.). 1 Oct 1972. 214p. Dep. NTIS.

The results of nine technical studies concerned with the proposed Wagon Wheel Project are presented. Information is included on: predicted ground motions; predicted effects of ground motion; radiation in the Wagon Wheel environment; off-site water well and natural spring documentation; preliminary predictions of chimney temperature; predictions of initial gas composition; release of radioactivity from Wagon Wheel; estimates of in-situ rock stresses; and ecological description of biotic communities of the Wagon Wheel environs. (L.C.L.)

11952 (UCRL-74017) CALCULATION OF ROCK FRACTURING FROM MULTIPLE NUCLEAR EXPLOSIVE SOURCES. Terhune, R. W.; Shaw, J. G. (California Univ., Livermore. Lawrence Livermore Lab.). 31 Oct 1972. 38p. (CONF-721108-7). Dep. NTIS.

From PNE panel meeting; Vienna, Austria (26 Nov 1972).

SOC calculations that agree with experimental measurements of the cavity radii, fracture initiation, and maximum extent of fracturing for the Gasbuggy and Rulison experiments are presented. Most importantly, a criterion is established that relates the number of times a zone in the calculations is fractured, with those regions around the detonation where extensive fracturing is observed experimentally. The calculations for both Gasbuggy and Rulison establish that the most distant zone that sequentially exceeds the fracture criteria three times is within the chimney or highly fractured region. The locations of these zones agree with the maximum distance at which it is necessary to hypothesize a sharp increase in permeability to match data from the gas-production and pressure-buildup tests. Having established a parameter related to extensive fracturing and permeability enhancement for single explosive sources, the first attempts at two-dimensional calculations of multiple explosive sources (detonated both sequentially and simultaneously) are presented. Two calculations of effects from sequentially detonated explosives indicate that, if the second explosive were located 5 cavity radii above the void or free surface created by the detonation of the first explosive, a permeable connection between the two fractured regions is assured. This translates to a spacing of 6 cavity radii from a previous explosion in which no chimney is formed, or 8.5 cavity radii from an explosion that produces a chimney height of 3.5 cavity radii. However, if the residual pressure in the lower void remains near overburden pressure, a permeable connection might not be obtained at larger spacings than above. Three calculations of effects from simultaneously detonated explosives indicate that the interval between the explosives is highly fractured to a radial distance that is more than 50% greater than that calculated for a single explosive. Also, the calculations indicate that the optimum spacing between such simultaneously detonated explosives is 8 to 10 cavity radii. This preliminary result is surprising, in that spacings required to ensure vertical chimney communication in the simultaneous detonation mode were expected to be smaller than those required for sequential firing. Further work to develop these calculational methods into predictive tools (especially for sequential detonations) is in progress. (auth)

11953 (UCRL-74306) COMPARISON OF COMPUTER MODEL PREDICTIONS OF NUCLEAR EXPLOSION EFFECTS IN HOGGAR GRANITE WITH EXPERIMENTAL MEASUREMENTS. Terhune, R. W. (California Univ., Livermore. Lawrence Livermore Lab.). 8 Nov 1972. 17p. (CONF-721126-1). Dep. NTIS.

From 2nd French-American technical exchange of geologic information relating to peaceful uses of nuclear explosives; Paris, France (20 Nov 1972).

A reliable predictive capability now exists which allows the calculation of effects produced by shock wave propagation in rock. This capability was achieved through the use of the numerical code SOC, with input parameters established by appropriate measurements of material properties. Calculations of cavity radius, peak shock stress, particle velocity and chimney height (as predicted by the extent of rock fracturing) have been confirmed by data from various experiments involving underground nuclear detonations. Using this technique, predictions were made of the explosion effects for Wagon Wheel, a proposed gas stimulation experiment in Sublette County, Wyoming. The failure envelope measured for Wagon Wheel sandstone indicated a shear strength similar to strengths measured for granites, and much greater than those measured to date for other sandstones. It was found that a SOC calculation using the Wagon Wheel material properties agreed with many of the field measurements carried out in conjunction with nuclear detonations in the Hoggar Granite Massif. Because of inherent differences between the stress-strain relationships of granite and sandstone these somewhat surprising results indicated the need for further study of the material properties of Hoggar granite, as well as a review of the calculational procedures used. An analysis is presented of those material property measurements as used in SOC, focusing on both the differences and similarities between results obtained by the use of material properties of the Hoggar granite and the Wagon Wheel sandstone. (auth)

Protective Structures and Equipment

Refer also to abstract 13962.

11954 STROITEL'STVO BYSTROVOZVODIMYKH UBEZHISHCH I PROTIVORADIATSIONNYKH UKRYTII. (Construction of Rapidly Erected Shelters Against Radiation). Ostroukh, F. I. Moscow; Voennoe Izdatel'stvo Ministerstva Oborony SSSR (1972). 136p.

The design and construction of fallout shelters are described which are capable of being erected in a relatively short time for the protection of municipal populations and rural groups. Different materials are utilized in the examples, and recommendations are offered for the use of reinforced concrete. Various devices are described for providing a fresh air supply and in other ways rendering underground and other types of shelters habitable. (KSW)

11955 NOTE ON THE MEASUREMENT OF RADIOACTIVE AEROSOLS. Spurny, K. R.; Lodge, J. P. Jr. (Inst. of Physical Chemistry, Prague). J. Aerosol Sci.; 3: No. 5, 407-9 (Sep 1972).

The new types of pore filters (nuclepore and golden membrane) available for measurements of aerosol concentration, aerosol particle size and particle size distribution, seem to be more convenient for practical investigations in industry and mines than the classical compact and heavy diffusion batteries. Some ways of applying these filters for the measurement and analysis of radioactive aerosols, for example in uranium mines, are discussed. (auth)

Safety Engineering

Refer also to abstracts 12535 and 13978.

Vacuum Engineering

Refer also to abstract 12052.

11956 ULTRA HIGH VACUUM SYSTEM FOR ION-SOLID COLLISION INVESTIGATIONS CONNECTED TO A CONVENTIONAL ION ACCELERATOR. Holmen, G.; Kugler, E.; Almen, O. (Chalmers Univ. of Tech., Goteborg). Nucl. Instrum. Methods; 105: No. 3, 545-50 (1972).

A uhv system that can be connected to a conventional ion accelerator is described. It has been used for about 4 y for sputtering and secondary electron emission experiments. The rest-gas pressure can be in the 10^{-10} torr range during operation.

The angular dependence of Ge(110) self-sputtering is determined. (4 figures, 1 table) (auth)

11957 SORPTION OF GASES IN THE ION BOMBARDMENT OF GLASS SURFACES. Radzhabov, T. D. pp 52-9 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A review is presented of ionic pumping and the interaction of positive gas ions with glass surfaces. Both sorption and desorption are covered. (29 references) (DLC)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 12147.

11958 RADIOACTIVITY OF MAGMATIC ROCKS OF HETEROTYPICAL FORMATIONS OF THE CAUCASUS DEPENDING ON THE COMPOSITION AND THE GEOSTRUCTURAL POSITION. Afanas'ev, G. D.; Kondakova, S. V.; Tseitlin, S. G. (Inst. of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 4, 940-3(1 Aug 1972). (In Russian).

The U and Th contents of igneous rocks of equal ages but of heterotypical formations of northern Caucasus were determined and tabulated with corresponding SiO_2, K_2O, and Na_2O analyses. Discussion of these data is focussed on granatoid intrusive formations, and effusive-extrusive formations of basic, trachytoid, and acid compositions. (K.S.W.)

11959 URANIUM CONCENTRATIONS IN NATURAL STRATIFIED ALUMINOSILICATES. Gavshin, V. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 205: No. 4, 956-9(1 Aug 1972). (In Russian).

Various kinds of aluminosilicates which contain from a few tenths of a percent to 4% of U are discussed: micas such as biotite and chlorite, and in certain sandstones. The phenomenon of α-tracks in microradiographs is considered with respect to U concentrations in the aluminosilicate rocks. (K.S.W.)

11960 PRIBORY DLYA RADIOMETRICHESKOGO OBOGASHCHENIYA RUD. (Equipment for the Radiometric Beneficiation of Ores). Kreindlin, I. I.; Markova, R. A.; Paska, L. M. Moscow; Atomizdat (1972). 240p.

Basic theory of radiometric equipment for ore beneficiation and functional design of ore-sorting radiometers are discussed in detail. Radiometers for rapid analysis and control instrumentation for automation of ore enrichment and processing are described. Circuit diagrams are supplied for the purpose of illustrating the construction of equipment components. (75 references) (KSW)

Radioactive Effluents

Refer also to abstracts 14193 and 14219.

11961 (DOCKET-50332-28) BARNWELL NUCLEAR FUEL PLANT. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). 3 Jan 1973. 76p. Dep. NTIS.

The beneficial and adverse environmental effects are considered as follows: unused fissile material equivalent to the annual conservation of a natural resource contained in approximately 1,500,000 tons of uranium ore. Capital expenditures for construction and operation of the plant will increase revenues in the form of wages and taxes to nearby communities. The effects of site preparation on the environment have already occurred. There will be no addition of radioactivity to liquid effluents. The gaseous release of radioactivity will be reduced to as low as practicable so as not to cause a discernible environmental effect. The prospective radioactive releases may result in an annual whole-body dose at the site boundary of about 1.1 mrem, and about 30 man-rem to the population within 50 miles of the plant. Design includes provisions for addition of krypton recovery facilities, if necessary, when the technology being developed is sufficiently demonstrated to be reliable and safe. The high-level radioactive liquid wastes will be stored on site in tanks pending conversion to a suitable solid form for transfer to a Federal repository. The fuel element hulls and plutonium contaminated solid wastes will be stored by burial. (M.C.G.)

Radioactivity Monitoring and Transport

Refer also to abstract 12330.

11962 (EUR-4866) RADIOACTIVITY AND WATER SUPPLIES. Lettinga, G. (Interuniversitair Reactor Institutt, Delft (Netherlands). Technische Hogeschool, Delft (Netherlands)). 1972. 198p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 300.-.

An investigation was made of the applicability of peat, chemically modified peat, clay and activated carbon for the removal of radionuclides (i.e., of Sr, Cs, Co, Mn, Ce, Ru, I) from aqueous solutions. It was found that natural peat pairs a reasonable ion exchange capacity (approximately 1 meq/g at pH 6) with a pronounced specificity for higher valency cations, especially the cations of the transition elements and of the rare earth elements and for cationic Ru-complexes. Relative to the alkaline elements also the earth alkaline elements are sorbed with a high selectivity. However, within the last group a strong competing action exists between the various species, e.g., peat shows a slight preference for Sr over Ca only at pH < 3.5. Strong indications were obtained that humic acids play a predominant part in the behavior of heavy metal ions in aqueous systems. By heating peat in air at a temperature of from 120 to 160°C with either dilute or concentrated H_2SO, a product is obtained with strongly improved properties over the natural peat, i.e., ion exchange capacity (being 2 to 3.5 meq/g at pH 6), chemical and mechanical stability, swelling properties and selectivity for Sr relative to Ca. Modified peat therefore may be considered as eminently suitable for decontamination of radioactively contaminated aqueous solutions. For the removal of radiocesium some K-fixing Dutch clay deposits, such as Ammerzoden clay, can advantageously be applied. Radioiodine can be removed from aqueous solutions rather effectively by adding activated carbon $+Cl_2$, provided the sorption properties of the carbon with respect to iodine are well known and the conditions are scrupulously controlled. Even with peat $+Cl_2$ an appreciable removal of radioiodine can be achieved under certain conditions, i.e. pH < 4 and a contact time of several hours. (auth)

11963 (PROT-SAN-10/70) DATA ON ENVIRONMENTAL RADIOACTIVITY COLLECTED IN ITALY (JANUARY-DECEMBER 1969). (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1970. 292p. Dep. NTIS (U. S. Sales Only).

Data from radioactivity monitoring in Italy during 1969 are presented. Information is included on: gross beta activity in ground-level atmosphere; ^{137}Cs, ^{239}Pu, ^{89}Sr, ^{90}Sr, and ^{95}Zr content in fallout; ^{137}Cs and ^{90}Sr content in fish, milk, industrial food products, surface waters, and vegetables; ^{137}Cs content in beef samples; and the locations of the monitoring network stations. (LCL)

11964 (RISO-267) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1971. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 18p. Dep. NTIS (U. S. Sales Only).

Measurements of fallout radioactivity in Greenland in 1971 are reported. Strontium-90 (and ^{137}Cs in most instances) was determined in samples of precipitation, seawater, vegetation, animals, and drinking water. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1971 are given. (auth)

11965 LOW-LEVEL RADIOACTIVITY MEASUREMENTS ON ALUMINIUM, STEEL, AND COPPER. Rodriguez-Pasques, R. H.; Steinberg, H. L.; Harding, J. E.; (and others) (National Bureau of Standards, Washington, DC). Int. J. Appl. Radiat. Isotop.; 23: No. 10, 445-64(Oct 1972).

The radioactive contamination levels in samples of aluminum, steel and copper, supplied by a number of producers of these materials have been measured and activities have been assigned to possible natural radioelements. These activities were found to lie in the range of 0.02 to 0.6 pCi/g of parent radionuclide. The decay with time of some contaminants has been observed. (auth)

11966 ^{228}Ra: APPLICATION TO THERMOCLINE MIXING STUDIES. Moore, W. S. (Naval Oceanographic Office, Chesapeake Beach, MD). Earth Planet. Sci. Lett.; 16: No. 3, 421-422 (Nov 1972).

Radium-228 is easily measurable in surface ocean waters but its concentration decreases abruptly in the thermocline. This strong gradient should prove useful in studies of the exchange rate of water through the main thermocline. Radium-228 should complement cosmic-ray-produced and fallout isotopes which have been applied to such studies. (auth)

Atmosphere

11967 (KURRI-TR-86) LOG NO. 6 OF RADIATION MONITORING WITHIN THE LABORATORY BUILDINGS (1969). Katsurayama, Yukinori; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). 1971. 21p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The experimental reactor of the Kyoto University went critical in 1964. The report summarizes the radiation monitoring log for 1969. The data indicate the maximum and minimum monthly dose

levels in the reactor room, the β and γ radiation levels in the hot laboratory, the tracer laboratory, and the waste disposal building. In addition, the contamination of the surfaces in the reactor room, the radioactivity of the stack gases, dust particles, and liquid effluents were measured and tabulated. The various instruments and their placement within the building complex are also indicated. Although the present monitoring systems appears to be adequate, some improvements are suggested. (TTT)

11968 (KURRI-TR-88) LOG NO. 7 OF RADIATION MONITORING WITHIN THE LABORATORY BUILDINGS (1970). Katsuyarama, Yukinori; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). 1971. 30p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The report represents the log of monitoring operations within the buildings of the Kyoto University research reactor facility for the year 1970. The monthly maximum, minimum, and average radiation levels are presented for each building in tabular form. As a new feature with respect to previous reports in this series is the monitoring of neutron leakage from the LINAC facility, measured at the top of the building. Several monitoring systems and arrangements of instruments were tried out, listing the actual findings, procedural modifications, and changes in the activities of the assigned personnel. A scintillation-type gas monitor is used jointly with the instruments presently on line to determine the activity of the stack gases; the new unit includes a 3 in. × 3 in. NaI(Tl) crystal and an RCA 8054 photomultiplier tube. It is planned to install computer-controlled on-line monitors, in order to ease some of the problems encountered in routine monitoring operations. (TTT)

11969 (NYO-3425-6) PROGRESS REPORT FOR THE PERIOD APRIL 1, 1972 THROUGH NOVEMBER 15, 1972. Reiter, Reinhold (Fraunhofer-Gesellschaft, Garmisch-Partenkirchen (West Germany). Physikalisch-Bioklimatische Forschungsstelle). 30 Nov 1972. Contract AT(11-1)-3425. 31p. Dep. NTIS.

Activities during the reporting period are reviewed. Information is included on aerosol sampling, processing of aerosol samples, meteorological analysis, and results of analyses as related to specific time periods. (J.R.D.)

11970 STRATOSPHERIC CONCENTRATION OF ^{14}C DURING 1967–1969. Vinogradov, A. P.; Devirts, A. L.; Dobkina, E. I.; Ogorodnikov, B. I.; Petryanov, I. V. (Inst. of Geophysics and Analytical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 4, 824-6(1 Aug 1972). (In Russian).

Aerostat flights were made in 1967 to 1969 above the central portion of the European territory of the USSR (northern hemisphere) for the purpose of collecting samples at heights of 12.5 to 31 km for radiocarbon measurements. On the basis of the data obtained, the average time of residence of CO_2 in the upper stratosphere of the northern hemisphere is about seven years, that in the troposphere about 9.9 years. Compared with 1963 data, the ^{14}C concentration for the years 1968 and 1969 had been reduced by factors of 4.8 and 5.7, respectively. (K.S.W.)

11971 TRITIUM IN RAIN AS AN INDICATOR OF AIR-MASS SOURCE. McNaughton, D. L.; Wurzel, P. (Univ. of Rhodesia, Salisbury). Tellus; 24: No. 3, 255-9(1972).

Tritium analysis of daily rainfall during the 1968/69 rainy season in Rhodesia revealed a correlation between air-mass origin and its tritium content. Tritium values of over 100 tritium units were found on all occasions when a north-westerly airstream had brought lower troposphere air to Rhodesia from Angola or the Congo. When the low-level trajectory suggested an Indian Ocean origin in a north-easterly air stream, the tritium values did not exceed 51 T.U. It is thus suggested that a large proportion of the moisture in north-westerly air is of northern hemisphere origin, whereas the north-easterlies originate in the southern hemisphere. The north-easterlies probably form part of an anticyclonic circulation centered just east of Rhodesia, while the north-westerlies appear to constitute part of an equatorial "drift," having started off as north-easterlies in the northern hemisphere. Analysis of eight years of monthly rainfall samples from Salisbury shows that high tritium values occur during the main rainy season, which is consistent with the air-stream explanation. (auth)

11972 ATMOSPHERIC DISPERSION MODELS FOR THE KO-RI NUCLEAR POWER PLANT. Lee, Yang Hoon. J. Korean Meteorol. Soc.; 6: No. 2, 75-8(1970). (In Korean).

The meteorological dispersion of the leakage from the reactor building has been calculated, using Pasquill's dispersion model. The model was modified to account for additional dispersion of the leakage due to turbulence in wake of reactor building. Conservative dispersion characteristics applicable to four time periods were selected based on the weather data collected during the period September 1969 through August 1970 at the site. (Korean Sci. Abstr.)

11973 PERSISTENCE OF WIND DIRECTION. Shirvaikar, V. V. (Bhabha Atomic Research Centre, Bombay). Atmos. Environ.; 6: No. 12, 889-98(Dec 1972).

Persistence of wind direction is one of the significant parameters in dosage evaluation from short term releases of pollutants to the atmosphere. The topic is studied in detail using the continuous wind data from three nuclear power station sites in India. It is found from the analysis that longer persistence periods are less frequent. The frequency of occurrence of different persistence periods obeyed a log-normal distribution at two sites whereas at the third site, though the behavior was qualitatively similar, no known analytic function could be fitted. The extremes and the averages of the wind speeds averaged over individual persistence periods showed a dependence upon the persistence period as follows; the average maximum wind speed decreased with persistence, the average minimum wind speed increased with persistence, the average of the average wind speed first increased with increasing persistence and then tended to a stable value. Such analysis is useful in defining the worst meteorological conditions at nuclear station sites for applications in hazard evaluation. Some of the applications of the persistence analysis are discussed, and it is shown that dosage at any site from short term continuous release of fission products has a maximum and that this maximum, which is different for different sites, can be used to grade the sites. An expression for return periods of persistences has been derived. This expression gives the return period in actual time units. (auth)

11974 NUCLEAR AND FOSSIL-FUELED PLANTS GENERATING ELECTRICITY. THEIR ENVIRONMENTAL HEALTH HAZARDS. J. Amer. Med. Ass.; 222: No. 10, 1281-3(4 Dec 1972). Press, Edward (Oregon State Public Health Office, Portland).

The environmental hazards from power plants fueled by nuclear and fossil fuels are compared. An estimate is presented of the typical annual release of the major radioactive and nonradioactive chemicals to the environment from a generating plant producing 1,000 megawatts of electricity a year, sufficient for the needs of approximately one million people, and fueled by a nuclear pressurized water reactor, coal, oil, or gas. Data are given on the amounts of ^{131}I, ^{85}Kr, ^{133}Xe, and tritium released from the reactor, the half-life of each, and the contribution of each to the annual radiation dose of man. Data are also given on the amounts of sulfur oxides, hydrocarbons, carbon monoxide, aldehydes, particulates, ^{226}Ra, ^{228}Ra, and ^{232}Th released to the environment from a coal-fueled plant. The data show that only extremely small traces of radioactivity are released to the environment and the possibility of any uptake by man is remote. It is pointed out that both fossil-fueled and nuclear-fueled plants release waste heat to the environment, with greater amounts released by nuclear-fueled plants in relation to the electricity generated. A 1,000 megawatt electrical nuclear plant operating at 3,000 megawatt total power for 85% of a year would release enough waste heat to raise the temperature of 3.380×10^{12} gallons of water one degree C. This volume of water is about 6% of the annual flow of the Columbia River. This thermal supplement of the environment can be used for warm water irrigation of agricultural lands, for the improvement of shellfish production, for the improvement of recreational waters, or for heating for greenhouses or residences, in which case it would be considered an asset rather than a pollutant. The possibility of a catastrophic accident involving both fossil-fueled and nuclear-fueled power plants is considered. The built-in safety features of power reactors that would prevent contamination of the environment in the event of an accident are discussed. (C.H.)

11975 ^{85}Kr AS AN ENVIRONMENTAL CONTAMINANT. Inoue, Y. (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 7: No. 3, 157-61(Sep 1972). (In Japanese).

Problems of environmental contamination by ^{85}Kr were investigated. ^{85}Kr is produced by fission of nuclear fuels and most of it is discharged to the atmosphere during the reprocessing of spent fuels. Because it is a rare gas, it is difficult to retain by conventional methods. Once discharged, it remains for a long time in the atmosphere and results in global contamination as well as local contamination. The discharge rate at currently-operating reprocessing plants is about 4×10^3 Ci/d^{-1} per ton/d^{-1} and the annual average concentration of ^{85}Kr at a few kilometers is about 5×10^3 pCi/m^{-3} and the corresponding average gonad dose and skin dose are 85 $\mu rad/y^{-1}$ and 10.5 $mrem/y^{-1}$ respectively. The concentration of ^{85}Kr in the atmosphere is about 15 pCi/m^{-3} in 1970, but for the year 2000 the predicted value is 2500 pCi/m^{-3} and the corresponding annual skin dose is 5200 μrad. The status of the work on ^{85}Kr removal and the uses of recovered one are also reviewed. (auth)

Soil

Refer also to abstract 12364.

11976 (COO-414-18) DETAILED CHARACTERIZATION OF SOIL AND VEGETATION ON SELECTED SITES TO SERVE AS BASIS FOR FUTURE EVALUATION OF EFFECT OF RADIOACTIVE CONTAMINATION. Final Technical Report, March 1971–August 1972. Haghiri, F. (Ohio Agricultural Research and Development Center, Wooster). 1972. Contract AT(11-1)-414. 69p. Dep. NTIS.

The procedures and results of field investigations of the deposition and distribution of ^{90}Sr in soil and vegetation are presented. The first part of the study is concerned with the removal of ^{90}Sr from soil by runoff, leaching, and plant uptake as influenced by soil type and crop management practices. The second part of the study is concerned with the effects of burning of ^{90}Sr-contaminated plants on the migration of ^{90}Sr in the soil. The third part of the study is concerned with the effects of several compounds (urea-formaldehyde resin, Dresinol-40 rosin, Dresinol-205 rosin, and Vinsalyn-100 emulsion) on the availability of ^{90}Sr to plants from soils embedded in these compounds. (E.R.B.)

11977 MECHANISM OF RADON RELEASE IN ROCK MATRICES AND ENTRY INTO GROUNDWATERS. Andrews, J. N.; Wood, D. F. (Bath Univ. of Tech., Eng.). Inst. Mining Met., Trans./Sect. B; 81: 198-209(Nov 1972).

The radium and radon contents of groundwater sources have been determined. The radon contents of these waters greatly exceed the equilibrium activities that can be supported by their radium contents. A physicochemical study of the mechanism of radon release in fragmented rocks of various particle sizes shows that radon release is dependent on the extent to which fracture planes or grain boundaries intersect the rock fragments. On this basis, the mechanisms by which radon enters water from several kinds of aquifer are discussed. It is shown that the carboniferous water sources of the Mendip Hills must also contain water from the Devonian cores of the Mendip periclines. The significance of the results for geochemical uranium prospecting by the radon in soil air and radon in surface and groundwater methods is discussed. (auth)

Water

11978 COLUMBIA RIVER ESTUARY AND ADJACENT OCEAN WATERS. BIOENVIRONMENTAL STUDIES. Pruter, A. T.; Alverson, D. L. (eds.). Seattle; University of Washington Press (1972). 878p. $22.00. (TID-26212).

A separate abstract was prepared for each of ten chapters. Twenty-three additional chapters discuss the biological, chemical, and physical characteristics of the Columbia River Estuary and adjacent Pacific Ocean. (C.H.)

For abstracts of individual chapters see: 11979–11982, 11985–11989, and 12376.

11979 HISTORY OF HANFORD AND ITS CONTRIBUTION OF RADIONUCLIDES TO THE COLUMBIA RIVER. Foster, R. F. (Battelle Memorial Inst., Richland, WA). pp 3-18 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

Establishment of the plutonium-producing reactors in eastern Washington during the period 1943 to 1945 resulted in the discharge of cooling water that contained radionuclides to the Columbia River. Because these radionuclides appeared in the river and its estuary and in the adjacent North Pacific Ocean, studies of their significance to aquatic and marine life and to man were undertaken. These radionuclides have also served as unique and valuable tags for studies not only of the dispersion of the river water but also of the mechanisms and rates through which complex physical, chemical, and biological processes proceed. The earliest studies concerned with the possible impact of the Hanford plant on fish were begun in 1943 at the Applied Fisheries Laboratory, University of Washington. Very soon after the first reactors began operating, laboratory and field studies were begun at the Hanford site and have continued ever since. Public and scientific interest in radioactive waste and the presence of radionuclides in the environment increased substantially in the late 1950s, and this interest helped to stimulate a much broader based research effort, especially of the Columbia River estuary and of the adjacent North Pacific Ocean. (auth)

11980 METHODS FOR THE MEASUREMENT OF HANFORD-INDUCED GAMMA RADIOACTIVITY IN THE OCEAN. Osterberg, C. L. (Atomic Energy Commission, Washington, DC); Perkins, R. W. pp 637-62 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

Radioactivity in the Columbia River resulting from the operation of the nuclear reactors at Hanford Laboratories, Richland, Wash., provides a unique tracer of the river water at sea. Several of the radionuclides can be most easily measured in sediments and biota, with measurements in the water proving more difficult. Although organisms concentrate certain radionuclides, not all plants and animals have equal affinities for the same radionuclides. It therefore is desirable to sort the samples prior to analysis. Even this time-consuming practice has difficulties since sample size is often limiting, and there may be cycles in abundance and seasonal variations in concentration due to metabolic differences, and organisms tend to reflect the average of their past environments. It seems best, therefore, to measure the radioactivity directly in the water. Sample size is a restriction if seawater must be returned to the laboratory for analysis. This has led to the use of in situ gamma detectors, but here again limitations in sensitivity arise. To counter these limitations, large samples of water have been processed at sea, with relatively small concentrates (containing the bulk of the artificial radioactivity) being analyzed after return to the laboratory. In one series of experiments the concentrates were analyzed aboard ship to obtain a live-time distribution of Columbia River plume waters at sea. The most recent and most sensitive technique employs sorption beds, which remove radionuclides from many gallons of seawater. The concentrate, when analyzed with multiparameter gamma-ray spectrometry, reveals a number of radionuclides present in the sea. However, levels are so low that measurement remains a challenge to oceanographers interested in using these radionuclides as tracers of water motion. (auth)

11981 RADIONUCLIDE DISTRIBUTION IN COLUMBIA RIVER AND ADJACENT PACIFIC SHELF SEDIMENTS. Forster, W. O. (Oregon State Univ., Corvallis). pp 701-35 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

The distribution of several natural radionuclides and those from the Hanford nuclear reactors is described. Removal of these radionuclides from the water by suspended and stream-bed sediments creates a major reservoir of radioactivity in this ecosystem. Redistribution of particulate isotopes on the various sediment size fractions in the different environments illustrates the strength of bonding between the particles and the radionuclides. Significant changes in the activity levels of individual radionuclides were found to be dependent on local rainfall and spring floods as well as the oxidation potentials of particular sites in the estuary. Major changes in activities due to the Hanford reactor shutdown to 1966 were found. Paired radionuclides of different decay constants were used to determine the transport rate of fractionated surficial sediments as they move out from the estuary and across the shelf. Deposition rates were also calculated by this paired-tracer technique. The advantages of the specific-activity approach in determining sediment transport rates were briefly illustrated. Natural radioactivity of ^{40}K and ^{214}Bi was stripped from the gamma spectra of nearshore sediments, and the ^{65}Zn in the plume was found to change with depth, season, organic content, and particle-size distribution. (auth)

11982 SEDIMENT-ASSOCIATED RADIONUCLIDES FROM THE COLUMBIA RIVER. Gross, M. G. (Univ. of Washington, Seattle). pp 736-54 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

Gamma-ray spectrometry was used to determine abundances of naturally occurring radionuclides (^{40}K and ^{214}Bi), fallout fission products (^{95}Zr–^{95}Nb, ^{103}Ru–^{103}Rh, and ^{141}Ce), and radionuclides from the Hanford reactors (^{60}Co, ^{65}Zn, ^{51}Cr, and ^{54}Mn) in sediment from the northeast Pacific Ocean near the Columbia River mouth. Naturally occurring radionuclides were ubiquitous in the sediments; on the continental shelf their activity levels were nearly constant and generally exceeded the levels of other radionuclides except near the Columbia River mouth. Fission products were widely dispersed in 1963 and showed highest activities near the river mouth, as did the radionuclides from Hanford. Both the Hanford radionuclides and the fission products were slightly more abundant and more widespread north of the river mouth than south. Northward-setting near-bottom currents on the continental shelf off Washington and Oregon apparently cause the northward skewing of the distributions of Hanford and fission-product radionuclides. The surface layer (1 cm thick) of the sediment contains about 11% of the ^{51}Cr and about 14% of the ^{65}Zn reservoir supported by the average 1963 discharge of sediment-associated radionuclides from the Columbia River. The total reservoir of radionuclides in the continental-shelf sediment in the area studied may be as much as three times as large as the activity of the 1-cm-thick surface layer. (auth)

Ecosystems and Food Cycles

Refer also to abstract 12380.

11983 (CEA-CONF-2126) DEPOSITION OF ^{90}Sr AND CONTAMINATION OF MILK. PROPOSITION OF A MODEL OF TRANSFER. Coulon, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 12p. (CONF-720818-2). Dep. NTIS (U. S. Sales Only).

From 2nd international conference on strontium metabolism; Glasgow and Strontian, Scotland (16 Aug 1972).

A biological model was developed for the transport of ^{90}Sr through food chains to milk following acute contamination of the atmosphere. The model may be adapted for use following foliar contamination of vegetation used as food for cattle or following ^{90}Sr uptake by plant roots from soil. (CH)

11984 (EUR-4885) LEVELS OF RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT AND THE FOOD CHAIN. Annual Report, 1971. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 58p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 70,-.

During 1971, the EURATOM/CEA Association worked on various projects concerning the radioactive pollution of the environment and the food chain. Research into factors involved in the transport of ^{58}Co, ^{60}Co, ^{51}Cr, ^{134}Cs, ^{137}Cs, ^{131}I, ^{85}Sr, ^{90}Sr, and ^{65}Zn from fallout or other sources of pollution to man has been interpreted and oriented towards the study of the problems posed by activation products. The study of chemical pollution associated with radioactive pollution was continued, particularly in a marine environment. (CH)

11985 RADIOACTIVE AND STABLE NUCLIDES IN THE COLUMBIA RIVER AND ADJACENT NORTHEAST PACIFIC OCEAN. Forster, W. O. (Oregon State Univ., Corvallis). pp 663-700 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

The results are presented of detailed studies of the downstream fate of radionuclides introduced at the Hanford site. Radionuclides associated with particulate matter or found in solution decrease in specific activity as the result of their physical decay rate, biogeochemical removal from the ecosystem, dilution by tributaries, and holdup by dams. The change in the concentration level and in the specific activities for the two forms, soluble and particulate, is not necessarily similarly influenced by downstream factors. (auth)

11986 RADIOECOLOGY OF ^{65}Zn IN ALDER SLOUGH, AN ARM OF THE COLUMBIA RIVER ESTUARY. Renfro, W. C. (Oregon State Univ., Corvallis). pp 755-76 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

The results are reported of an investigation of the transfer of ^{65}Zn through Alder Slough, a small, discrete segment of the Columbia River estuary located some 600 km downstream from Hanford, Wash. Zinc-65 activity levels were measured in water, sediments, algae, emergent vegetation, and in animals. The activity level increased in the spring, fell in midsummer, and continued at low level throughout the remainder of the year, even when concentrations of radionuclides in Columbia River organisms near Hanford were increasing. Organisms in the lowest trophic levels had the shortest ecological half-life, and each succeeding trophic level showed a longer ecological half-life (i.e., time required to reduce radionuclide specific activity by one-half by radioactive decay and biological turnover in spite of continued uptake of the radionuclide through the food web). (auth)

11987 SEASONAL AND AREAL DISTRIBUTIONS OF RADIONUCLIDES IN THE BIOTA OF THE COLUMBIA RIVER ESTUARY. Renfro, W. C. (Oregon State Univ., Corvallis); Forster, W. O.; Osterberg, C. L. pp 777-98 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

The distribution of some radionuclides in organisms of the Columbia River estuary is described. Because zinc is of importance in the biological system and can be readily measured, ^{65}Zn was studied most intensively. Other radionuclides measured at least once in the biota were ^{60}Co, ^{54}Mn, ^{51}Cr, ^{46}Sc, ^{32}P, and some fallout fission products. Phytoplankton and zooplankton had relatively high but variable amounts of ^{65}Zn and ^{51}Cr with no apparent seasonal or areal trends. The specific activity of ^{65}Zn varied seasonally in fish and shrimp and generally reached a maximum in spring or summer. Starry flounders (Platichthys stellatus) and staghorn sculpins (Leptocottus armatus) from upstream locations exhibited higher radioactivity levels than those from stations farther downstream. During the period of this study (1964 to 1968), there was an obvious decline in ^{65}Zn specific activities of organisms. At the same time the number of reactors in operation at Hanford was reduced from eight to three. (auth)

11988 TOTAL PHOSPHORUS AND ^{32}P IN SEAWATER, INVERTEBRATES, AND ALGAE FROM NORTH HEAD, WASHINGTON. Isakson, J. S.; Seymour, A. H. (Univ. of Washington, Seattle). pp 799-818 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

From September 1965 to September 1966, seawater and several species of invertebrates and algae were sampled monthly from North Head, Wash., a headland 4 km north of the mouth of the Columbia River. The amounts of total phosphorus and ^{32}P in these samples varied independently. In general, the seasonal variation in values was much more pronounced for ^{32}P than for total phosphorus, and the peak values for the former occurred most frequently in the period from April to June. After a 45-day shutdown of all the Hanford reactors, the lowest ^{32}P values for the year were observed in most organisms. The concentration factors for ^{32}P were lower than those for total phosphorus for one or both of the following reasons: the physical decay of ^{32}P as it moves from the water into the organism and its decay within the organism prior to its collection for analysis; and the nonequilibrium state between ^{32}P in the water and in the organism. The concentration factors by tissue for both forms of phosphorus were greatest for the G.I. tract plus contents and the digestive gland (mesosoma) of razor clams and mussels, respectively, and were least for shell. (auth)

11989 ^{65}Zn IN BENTHIC INVERTEBRATES OFF THE OREGON COAST. Carey, A. G. Jr. (Oregon State Univ., Corvallis). pp 833-42 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

Radioecological studies of benthic invertebrate fauna off central and northern Oregon demonstrate that ^{65}Zn entering the northeast Pacific Ocean via the Columbia River is concentrated by the sublittoral, bathyal, and abyssal fauna. The ^{65}Zn (picocuries per gram ash-free dry weight) and specific activity (microcuries of ^{65}Zn per gram of zinc) in the fauna decrease fairly regularly with distance from the river and markedly with depth within the first 400 m. The major route of the isotope to the fauna appears to be through the food web. The radioecology of the benthic organisms differs from that of the pelagic fauna. (auth)

11990 ESTIMATION OF DOSE LOADS OF ISOTOPES IN MILK IN CASE OF LENGTHY RADIOACTIVE FALLOUT. Prokof'ev, O. N. (Leningrad Scientific-Research Inst. for Radiation Hygiene). Gig. Sanit.; No. 10, 51-3(Oct 1972). (In Russian).

The kinetics of the concentrations of ^{131}I, ^{89}Sr, ^{90}Sr, and ^{137}Cs in milk due to multiple fallout of isotopes on pastures after their intense injection into the atmosphere were studied. By means of determining the time of retention (^{131}I—46 days, ^{89}Sr—216 days) of the isotope in the milk, simple formulae were obtained that connected the concentration of the isotope in the milk with the dose load due to them in the appropriate critical organ of the infant. The author assessed the concentration of isotopes in the milk, corresponding to dose load at a level of 0.1 dose of occupational irradiation. (auth)

Radiometric Techniques

11991 CHANGE DURING ANNEALING OF ETCH FIGURE PATTERNS OF FRAGMENTS OF FISSIONABLE NUCLEI IN PHLOGOPITE CRYSTALS. Vorob'eva, I. V.; Geguzin, Ya. E. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1369-72(Aug 1972). (In Russian).

Samples of phlogopite were examined for tracks left by fissioned naturally occurring ^{238}U, or, alternatively, annealed to remove such natural tracks, and then subjected to fission fragments of ^{252}Cf. Both types of samples were simultaneously annealed at 750°C repeatedly, exposing fresh surfaces by cleaving the crystals. Two types of etch of figures could be distinguished: triangular and hexagonal. A qualitative explanation of this phenomenon is offered. (K.S.W.)

11992 FISSION-TRACK STABILTIY IN VOLCANIC GLASS OF DIFFERENT WATER CONTENTS. Lakatos, S.; Miller, D. S. (Rensselaer Polytechnic Inst., Troy, NY). J. Geophys. Res.; 77: No. 35, 6990-3(10 Dec 1972).

Experiments to reveal the influence of water concentration in obsidian upon the annealing rate of fission tracks showed that a 2.2% H_2O obsidian would lose 70% of its tracks in 1 My if held at 30°C. Data obtained at three temperatures (227, 253, and 282°C) give the possibility of extrapolations to geologically significant

times. Care must be taken in choosing the proper samples for fission-track analysis of glasses. (auth)

11993 DETERMINING THE THICKNESS OF FISSURES IN ROCKS DURING RADIOISOTOPE INSPECTION OF BOREHOLE CEMENTATION. Wozniak, J. (Inst. of Nuclear Techniques, Krakow). Nukleonika; 17: No. 9, 467-72(1972).

The natural gamma-logging theory serves as a basis for a technique for determining the thickness of fissures in rocks during the radioisotope control of borehole cementation. Radioactive cement is injected into the borehole and penetrates the fissures. The gamma-logging is performed after the cement plug has been removed by drilling. The thickness of the particular fissures can be found from the registered intensity of gamma radiation. (auth)

Thermal Effluents

Refer also to abstracts 11912, 14193, and 14224.

11994 (ORNL-EIS-73-52(Vol.1)(No.1)) NSF-RANN ENERGY ABSTRACTS. A Monthly Abstract Journal of Energy Research. Guthrie, M. P. (ed.) (Oak Ridge National Lab., Tenn.). Jan 1973. Contract W-7405-eng-26. 15p. Dep. NTIS.

A bibliography of recent publications in the field of energy research is presented. The research publications are in the form of journal articles, semi-technical articles, reports, symposium proceedings, monographs, and books. 56 references are included. (J.R.D.)

11995 McGRAW-HILL'S 1972 REPORT ON BUSINESS AND THE ENVIRONMENT. Price, F. C.; Ross, S.; Davidson, R. L. (eds.). New York; McGraw-Hill, Inc. (1972). 316p.

The information is presented in chapters on environment and policy, laws and standards, environmental management, clean air technology, clean water technology, solid waste technology, recycling and reuse, cars and fuels, chemical process industries, construction, nonferrous metals, energy and generating industry, mines and mining, steel and metal working industries, noise, municipal waste treatment, measuring pollution, and special problems and solutions. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 13797 and 13993.

General Detectors and Monitors

Refer also to abstracts 11701, 12223, 12224, 12590, 12593, 13547, and 14254.

11996 (ACRH–1000–388) ADVANCE IN FUNDAMENTAL ASPECTS OF IMAGING SYSTEMS AND TECHNIQUES. Beck, R. N.; Zimmer, L. T.; Charleston, D. B.; Harper, P. V.; Hoffer, P. B. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Radiology). 1972. 56p. (CONF-721017–3). Dep. NTIS.

From Symposium on medical radioisotope scintigraphy; Monte Carlo (23 Oct 1972).

An analysis of the radionuclide imaging process is presented in an outline of the relationships between parameters describing the object, radiation detector system, numerical image, photo-recording system, and exposure image, assuming that the imaging system is linear and shift-invariant. Major image imperfections such as quantum noise and linear distortion are described quantitatively in terms of the sensitivity and spatial resolution of the detector and recording systems. Principles of system design are formulated: the maximum useful detector sensitivity is limited by the size of the smallest structures to be detected; the maximum useful recorder sensitivity is limited by the required signal-to-noise ratio (S/N) or confidence of detection. A theory of optimum-weighted multichannel imaging is described which permits maximization of S/N, utilizing the entire pulse amplitude spectrum. The effects of image processing on noise in the image are described quantitatively: smoothing tends to reduce image noise and increase linear distortion; sharpening tends to have the opposite effects. The use of a recording medium capable of a bipolar response (repeated local storage and erasure) permits on-line image sharpening or reduction of linear distortion that is introduced by the detector system (which is described as a low-pass filter of spatial frequency components comprising the object). The need for a more general formulation of the imaging process, including the effects of nonlinear and nonstationary components on diagnostic image quality, is emphasized. The use of Receiver Operating Characteristic (ROC) curves is suggested as a means for comparing and evaluating diagnostic image quality in terms of the accuracy of the physician's performance in interpreting radionuclide images. The general principles, concepts, and terms used to describe and evaluate radionuclide imaging systems can be adapted to other imaging modes used in nuclear medicine. (57 references). (auth)

11997 (AD–743835) INSTRUMENTATION FOR STUDIES OF SOLAR XUV RADIATION. Final Report, July 1, 1968–December 31, 1971. Padur, J. P.; McGrath, J. F. Jr.; Wiederhold, P. R. (Comstock and Wescott, Inc., Cambridge, Mass.). 10 Feb 1972. Contract F19628-68-C-0239. 87p. (AFCRL–72–133). NTIS.

The design, development and construction of grazing-incidence telemetering monochromators used in rocket experiments to obtain measurements of solar extreme ultraviolet and soft x-ray (xuv) radiation in the upper atmosphere are described. Also, the intensity and wavelength calibration of these instruments to allow flight data to be converted to absolute values of solar radiation fluxes as a function of wavelength and the laboratory calibration instrumentation used to obtain this information are discussed. Finally, the field services and rocket launchings involving the flight instruments developed under this contract are discussed. (auth)

11998 (AD–745348) NONADIABATIC EFFECTS IN CLOUD CHAMBER EXPANSIONS. Eklund, T. I. (Brown Univ., Providence, R. I. Div. of Engineering). Jun 1972. Contract N000-14-67-A-0191-0001. 31p. NTIS.

An energy balance was applied to the expansion process that occurs in a Wilson cloud chamber, and the nonadiabatic effects were thereby quantified. Chamber pressure, volume, and optical transmission were recorded continuously on a high-speed oscillograph, and this yielded highly accurate data both for chamber pressure against volume and for onset of condensation as a function of time. Both moist and dry argon were tested, and comparisons with theoretical values of heat transfer were made. Effective polytropic coefficients were defined, and the polytropic coefficients for the wet argon tests were used to calculate critical supersaturation. These actual critical supersaturations were compared with those computed for equivalent adiabatic expansions. The critical supersaturations were compared with the data of Wilson and Powell and also with the predictions from classical nucleation theory. (auth)

11999 (AD–745579) THIN FILM WINDOW FOR GAS FLOW PROPORTIONAL DETECTOR. Final Report, February–August 1970. Theis, C. F.; Kay, T. D. (School of Aerospace Medicine, Brooks AFB, Tex.). Jul 1972. 18p. (SAM-TR–72–14). NTIS.

The gas flow proportional detector used for counting radioisotopes incorporates a Micromil window which covers the open end of an ionization chamber. When it becomes contaminated or damaged, the window, with supporting metal ring, must be replaced with a new one at significant expense. A procedure was developed to reuse the rings in making new windows which are referred to here as gas flow ultrathin (GFUT) windows. The GFUT window has these advantages: it can be made in the laboratory from material that costs less than one cent per window; it is stronger than the commercial window; and it can be washed and reused. The time required to remove a damaged window, place a GFUT window on the same ring, and replace the window in the gas flow detectors is only 30 minutes. GFUT windows can be used satisfactorily in Nuclear-Chicago models D-47 and D-470 or similar systems. (auth)

12000 (AD–747051) DEVELOPMENT AND CONSTRUCTION OF AN INSTRUMENT TO DETECT FISSIONABLE MATERIALS. Technical Report, May 1, 1969–December 15, 1971. Burton, B. S.; Anastasi, M. N. (Nuclear-Chicago Corp., Austin, Tex. Texas Nuclear Div.). May 1972. Contract F29601-69-C-0089. 72p. (AFWL-TR–71–145). NTIS.

A radiac set (AN/PDR-69) for surveying areas contaminated with fissionable materials has been developed for use in the field under adverse environmental conditions. Eight prototypes have been constructed; several of these have been subjected to environmental testing at Air Force Weapons Laboratory with generally satisfactory results. A scintillation probe, with pulse-height analysis, serves for selective detection of L X radiation or low-energy gamma radiation emitted by the contaminants or their daughters. A digital display indicates the counting rate in the pulse-height window. Design and development studies are discussed. Physical and operational characteristics of the instrument are described. (auth)

12001 (COO–1671–40) RESPONSE OF DETECTORS TO A MIXED RADIATION ENVIRONMENT. Katz, R. (Hammersmith Hospital, London England)); Sharma, S. C. (Nebraska Univ., Lincoln. Behlen Lab. of Physics). [nd]. 14p. (CONF-720561–1). Dep. NTIS.

From 1st symposium on neutron dosimetry in biology and medicine; Neuherberg/Munich, Germany (15 May 1972).

The response of many detectors (nuclear emulsion, scintillation counters, the Fricke dosimeter, LiF, glass, enzyme and virus inactivation) to track-segment irradiation with energetic heavy ions appears to be calculable from knowledge of the spatial distribution of local dose and two parameters which describe the detector: the dose, E_0, of gamma rays at which 63% of the detector "sensitive elements" are activated and the sensitive element "radius," a_0. By integration along the path, the response of the detector to a stopping particle may be found. Knowledge of the spectrum of secondary particles (as from neutron irradiation) enables calculation of the response of the detector to neutrons. The calculations suggest that it may be possible to use the response of a set of detectors of different inherent sensitivity to disentangle the spectrum of secondary particles in a general radiation environment, for subsequent prediction of cellular survival. (3 figures) (auth)

12002 (HEDL–SA–442) EFFECTS OF GAS MIXTURE, ELECTRODE SPACING, GAS PRESSURE, AND APPLIED VOLTAGE ON THE GAMMA PERFORMANCE OF FISSION COUNTERS. Holtink, N. C.; Philipp, L. D.; Wood, M. R. (Hanford Engineering Development Lab., Richland, Wash.). 3 Oct 1972. Contract AT(45-1)-2170. 24p. (CONF-721109–12). Dep. NTIS.

From International conference on nuclear solutions to world energy problems; Washington, DC (12 Nov 1972).

Neutron flux instrumentation requirements for the Liquid Metal Fast Breeder Reactor dictate the use of minimum-resolving-time electronics to reduce the interfering effects of gamma-caused pulse pileup signals. Experiments were performed to verify that improvements in collection time do, in fact, result in improved counting performance under high-gamma-level conditions through reduced fission counter collection time. Variations in gas mixture, gas pressure, electrode spacing, and applied voltage were

considered. It was found that choice of the best fill gas depends on the maximum voltage stress permitted; in the usual range (400 to 800 V dc) N_2 concentrations of 4 to 7% in an $Ar-N_2$ mixture gave the best results. An optimum pressure appeared to exist for a given voltage, gas mixture, and plate spacing. (8 figures, 1 table) (RWR)

12003 (JINR-P13-6759) MANUFACTURING AND EXAMINATION OF Ce(Li) DETECTORS. Vylov, Ts.; Egoshin, I. N.; Marinov, M. G.; Muminov, T. M.; Osipenko, B. P.; Sandukovskii, V. G.; Srnka, D.; Yurkovskii, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The technique, equipment, and special methods used for manufacturing Ge(Li) detectors are described. The main characteristics of the detectors are presented. The scheme is given of the detector current measurements up to 10^{-12}A, the potential of the device relative to the ground being more than 2 kV. The dependence of the energy resolution and photoefficiency on the detector volume is plotted. (auth)

12004 (JINR-P13-6784) TECHNIQUE OF MEASUREMENT OF EPITHERMAL NEUTRON BACKGROUND IN EXPERIMENTS ON THERMAL NEUTRON SCATTERING. Savenko, B. N.; Fel'dmann, K.; Hennig, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

A technique is suggested for measurement of the epithermal neutron background in the experiments on neutron scattering in the pulsed fast reactor IBR-30. The measurements are carried out simultaneously by two detectors located one after another in the scattered neutron beam path. Cadmium is used as a filter between these detectors. The nearest to the sample detector records all the neutrons scattered by the sample, while the next detector records the epithermal neutrons only. Since the total spectrum and the background are measured by independent detectors, the background measurement is carried out simultaneously with the basic measurements. (auth)

12005 (LBL-1(Vol.3)) INSTRUMENTATION FOR ENVIRONMENTAL MONITORING: RADIATION. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1 May 1972. 297p. Dep. NTIS.

The National Science Foundation has engaged the Environmental Instrumentation Group of the Lawrence Berkeley Laboratory (formerly Lawrence Radiation Laboratory) to conduct a survey of instrumentation for environmental monitoring. Instruments being investigated are those useful for measurements of Air, Water, Radiation, and Biomedicine related to environmental research and monitoring. Consideration is given to instruments and techniques presently in use and to those developed for other purposes but having possible applications to this work. The results of the survey include descriptions of the physical and operating characteristics of available instruments, critical comparisons among instrumentation methods and recommendations for the development of new instruments, and of promising methodology. The survey material is compiled in four loose-leaf volumes which will be periodically updated. Volume 3 as initially issued covers Ionizing Radiation: Accelerators, Calibration Methods, Gamma, X-radiation, Neutrons; Nonionizing Radiation: Microwaves, Lasers and Ultraviolet. Additional sections on Reactors, Dosimeters, Radionuclides and Infrared will be issued during the year. (auth)

12006 (LUIP-CR-72-8) WIDTH OF HEAVY ION TRACKS IN NUCLEAR EMULSIONS: A STUDY OF THE ENERGY DOSE CONCEPT FOR ION VELOCITIES $\beta \leq 0.3$. Rosander, R.; Jacobsson, L. (Lund Univ. (Sweden). Dept. of Physics). Jul 1972. 16p. (CONF-720724-2).

From 8th international conference on nuclear photography and solid state track detectors; Bucharest, Romania (10 Jul 1972).

Light absorption profiles of tracks of heavy ions have been recorded using a nuclear track photometer with a narrow slit. The tracks were produced by heavy, stopping, cosmic ray particles with charges in the interval $6 \leq Z \leq 26$. Measurements were made in both Ilford G5 and Ilford K2 nuclear emulsions. The experimental data are compared with the theoretical distribution of energy dose around the path of a passing ion. The dosage was calculated using the formalism of the track formation theory developed by Katz and coworkers. Fairly good agreement between experiment and theory is established for the measurements in Ilford K2 emulsion. For the measurements in Ilford G5 there are indications of some disagreement between experimental and theoretical widths. (auth)

12007 (ORNL-TM-3959) NEUTRON SENSOR DEVELOPMENT FOR EXTREME ENVIRONMENTS PROGRESS REPORT FOR PERIOD JANUARY 1, 1971 TO JUNE 30, 1972. Roux, D. P. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 39p. Dep. NTIS.

Basic investigations in fission counter development were made for application in the hostile in-core environment of LMFBR's. The studies comprised analyses, digital computations, and experiments to optimize the gamma rejection of fission counters and to formulate the gamma pile-up effect, shielding effect on the gamma response, and selection of gamma shields for fission counters. Electron drift velocity data were evaluated, and new data were obtained. From these studies, general considerations for optimization of fission counters are summarized. The electrical shield performance of high-temperature, mineral-insulated coaxial cables was tested, and electronic noise in current pulse preamplifiers was reduced. The design characteristics of a fission counter for operation at 750°F were determined. A detector was designed with a sensitivity of 1 count/sec-nv at a gamma flux of 3×10^6 R/hr. (auth)

12008 (ORNL-TM-4038) COMPUTER-BASED SCANNING SYSTEM. Bell, P. R.; McClain, W. J.; Ross, D. A.; McKeighen, R. E.; East, J. K.; Moore, E. C.; Edwards, C. L.; Goswitz, F. A. (Oak Ridge National Lab., Tenn.). Jan 1973. Contract W-7405-eng-26. 24p. Dep. NTIS.

A computer-based scanning system intended for on-line operation with a dual-head rectilinear scanner is described. A simple scanner-computer interface requires only five signals to fully describe the scan for the minicomputer. Display during acquisition and immediate processing and display of the data from the completed scan permit fast evaluation both for quality of scan and for possible abnormalities. Four display formats as well as smoothing by weighted averaging, antiscatter and antipenetration correction, and bounding are included in the software. Additional useful and informative routines included are a multicontrast enhancement display which provides an immediate quantitative assessment of the data and a validator routine which specifies small but statistically sound deviations that might be considered abnormal. (auth)

12009 (TID-26238) PROTON RECOIL DETECTOR CALIBRATION USING RESONANCE FILTERS. Twining, B. G. (Washington Univ., Seattle). 1970. 82p. Dep. NTIS.

Thesis.

A study was undertaken to outline a procedure for the calibration of proton recoil neutron detectors. The calibration incorporates resonance filters in combination with a neutron source rather than relying on the present method of using residual gases such as nitrogen or helium which undergo a reaction with thermal neutrons. The sources which were considered include the 1/E flux emitted from vertical hole number two of the University of Washington Nuclear Reactor, and neutrons from isotopic sources. The filter materials which were considered include iron, lithium fluoride, lithium carbonate, and lead. These materials should provide calibration points from about 25 keV to above 1 MeV. During the course of experimentation it was discovered that it was not practical to look for calibration points below 50 keV without the advantage of gamma discrimination. A total of 8 valid calibration points were obtained from 50 to 440 keV for the hydrogen filled detectors using the UWNR as a neutron source, and 22 from 258 to 1180 keV for the methane filled detectors using both the UWNR and PuBe isotopic sources. Using the calibration points described, an experimental value for the ^{14}N and ^{3}He gas calibration peaks was also determined. Finally, a code was written to handle the data gathered during calibration, and a detailed procedure is outlined. (auth)

12010 SINGLE PHOTON TIME MEASUREMENTS IN PARTIALLY COHERENT LIGHT. Scarl, D. B. (Polytechnic Inst. of Brooklyn). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 7-11(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

One of the simplest ways to get information about the statistics and coherence of a light beam is to measure the time between consecutive detected photons. The setup for a typical two-photon timing experiment is shown. A picture of the electromagnetic field, in which the photons are considered as bosons, is given to help in the understanding of counting and interference experiments. The theoretically expected two-photon counting rate is calculated and compared with experimentally measured time distributions; the agreement is good. The apparatus used in photon counting experiments is discussed; and the method for measuring the impulse response of the two-photon detection system, i.e., the distribution of times between output pulses when simultaneous single photoelectrons leave the cathodes of the two tubes, is described. One of the serious problems in two-photon counting is the inability to resolve short time intervals because of the time jitter of even the fastest photomultipliers. The photomultiplier output pulse jitter spreads the peak to about

1300 ps and reduces its height to about 20% above the background; but even with this spreading, important information about the statistics of the light beam can be measured. (6 figures) (R.W.R.)

12011 SINGLE PHOTON TECHNIQUES FOR PRECISION MEASUREMENTS OF OPTICAL WAVEFORMS FROM RADIATIVE DECAYS. Cova, S.; Bertolaccini, M.; Bussolati, C. (Politecnico, Milan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 18-33(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The measurement of optical wave forms in order to measure physical parameters (radiative lifetimes, etc.) is considered. The influence of the detection and measurement system and causes of systematic and random errors are analyzed. The inherently digital techniques based on single photon (SP) detection are shown to have definite advantages over analog techniques. Two basic SP techniques are considered: SP gated counting (SPGC) and measurement of SP delay distribution (SPDD); these are complementary and cover a time range from subnanoseconds to long times (>minutes). The time resolution, the effect of background, the random fluctuations, and other factors which set limits to the available measurement range are considered; and experimental results are reported. Extension to very low detected intensity and to the infrared spectral range is analyzed and experimentally tested. (10 figures) (auth)

12012 NEW CERAMIC ELECTRON MULTIPLIER. Sackerlotzky, O. H.; Belanger, V. J. (EMR-Photoelectric, Princeton, NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 63-70(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The design and performance of a new ceramic envelope electron multiplier are described. The tube uses hemispherically shaped $\frac{3}{8}$" diameter dynodes crimped into kovar cups. The dynode assemblies are alternately stacked between high-alumina ceramic rings and brazed into a rugged single-piece construction envelope. The structure has an outside diameter of 0.5 inches with an overall length of 2.75 inches, and is capable of withstanding extreme environmental conditions. The tube withstands 100 g shocks for 11 ms duration and random vibration levels of 1.3 g^2/Hz, and can be operated over a temperature range from liquid N_2 to 400°C. The electron optics of the discrete dynodes provide optimum interstage electron collection. The single-electron pulse height distribution at gains higher than 10^6 is nearly Gaussian and has a FWHM of approximately 0.6. Complete data on pulse height distribution characteristics are reviewed over the dynamic range of the device. The photon sensitivity of the device is discussed within the range of 58.3 to 150 nm, as well as the adaptability for charged-particle conversion between 3 keV. Fatigue characteristics are examined as a function of accumulated counts up to 10^{12}, exposure to controlled atmospheres of dry air and noble gases, and maximum counting rates up to 10 MHz. Applications for these detectors are reviewed, including their projected use in mass spectroscopy experiments on the Apollo 17 mission. (10 figures) (auth)

12013 MINIATURE PHOTOMULTIPLIER FOR SCINTILLATION AND SPACE USE. Duckett, S. W. (EMR-Photoelectric, Princeton, NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 71-3(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A rugged miniature photomultiplier was developed which is only 8 mm in diameter. The electron multiplying element is a single channel multiplier. Photoelectrons from the 5 mm diameter cathode are electrostatically focused into the channel multiplier without need for a funnel or cathode-to-channel bias. This photomultiplier is a two-terminal device and uses no external resistors. The high gain characteristics ($\sim 10^8$ at 3,000 V) and the single-electron pulse height distribution (FWHM $\leq$ 0.6) make the tube ideal for pulse-counting applications. The small diameter of this tube suggests applications in close-packed arrays and mosaics for scintillation imaging. This tube can be used as a scintillation spectrum analyzer with good resolution even at high gains where there are greater than 10^9 anode electrons per scintillation event. The structure can also be employed in a windowless configuration as a particle or x-ray detector. In this modification apertures as large as 5×7 mm^2 are possible. One use is as the detector in an Auger apparatus, where the high-gain output pulses allow precision digital data handling techniques and long drift-free integration time. (4 figures) (auth)

12014 PARALLEL-PLATE ELECTRON MULTIPLIERS. Tove, P. A.; Berg, S.; Andersson, L. P.; Ericsson, B.; Norde, H. (Uppsala Univ.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 85-94(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A review is given of the properties of parallel-plate electron multipliers, and present development work is described. In particular, the type of multiplier fabricated by RF sputtering of separate potential divider and secondary emission layers is discussed. This allows optimization of the two functions. Typical plate dimensions are 20×20 mm, with a separation of $\approx$0.3 mm. The theories for the straight pipe-shaped multiplier and the parallel-plate multipliers are discussed, and a comparison is made with measurements. The influence of the geometry is discussed, including optimum plate spacing. A difference compared with tubular multipliers is that electron avalanches spread sideways, because of statistics and electric repulsion effects. Studies of pulse shapes and timing properties are reported. Current pulses at the output are about 10 ns long for each electron avalanche. Several superimposed avalanches caused by ionic feedback build up the integrated voltage pulse to a length of a few tenths of a μs. (20 figures) (auth)

12015 PROPORTIONAL COUNTER PHOTON CAMERA. Borkowski, C. J.; Kopp, M. K. (Oak Ridge National Lab., TN). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 161-8(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A gas-filled proportional counter camera that images photon emitting sources was built and tested. This camera measures and displays the impact location of individual photons in an energy range between 1 and 150 keV, and permits pulse shape and energy discrimination for background reduction. Possible fields of applications for this camera include nuclear medicine, nuclear physics, x-ray diffraction, and related areas. The signal processing of the camera is based on further improvements and simplifications of the rise-time method as applied to multiwire position-sensitive counters. Materials inside the counter were selected so that the camera can be used over long periods of time without purification of the counter gas. The sensitive area of the camera is 200×200 mm^2, and the size of each picture element is 1×1 mm^2; thus 40,000 picture elements are resolved. Counting rates of up to 20,000 photons/s do not appreciably affect the spatial resolution. The camera was tested only with low-energy photons (<30 keV) to determine the properties and applicability of the camera; however, by use of high-pressure (>10 atm) Xe counter gas, a useful detection efficiency (>30%) and good spatial resolution are expected for 150-keV photons. (12 figures) (auth)

12016 MULTI-WIRE PROPORTIONAL CHAMBER FOR NUCLEAR MEDICINE APPLICATIONS. Kaufman, L. (Univ. of California, San Francisco); Perez-Mendez, V.; Shames, D.; Stoker, G. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 169-72(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A xenon-filled multiwire proportional chamber (MWPC) with delay-line readout of coordinates for nuclear medicine applications is described. This system, with an active area of 30.5×30.5 cm^2, is being used to image internally administered radioisotope distributions in animals for research purposes. (auth)

12017 EXPERIMENTAL COMPARISON OF SCINTILLATION AND SEMICONDUCTOR DETECTORS FOR ISOTOPE IMAGING AND COUNTING. Brill, A. B.; Patton, J. A.; Baglan, R. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 179-89(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The excellent energy resolution of semiconductor detectors suggests their use in nuclear medicine. The effects of Compton and coherent scattering on image formation are considered first. Then various studies with Ge(Li) and Si(Li) detectors are described: these include activation analysis, radioassay, and imaging studies with Ge detectors, along with x-ray fluorescence for sample composition, flow studies, and imaging studies with Si(Li) detectors. The following conclusions were reached on the utility of semiconductor detectors in nuclear medicine. Ge detectors clearly are useful for counting radioactive samples for quantitative purposes. Stable tracers may be measured after neutron activation, with the high energy resolution of the detector making it possible to separate and measure photopeaks of different isotopes more accurately. In radioassay the use of Ge(Li) detectors permits one to do multiple tracer studies with a high degree of accuracy. Fluorescence x-ray analysis of biological samples also appears to have merit. In imaging procedures, Ge(Li) detectors are useful for dosimetry and metabolism studies in animals where large quantities of radioisotopes can be given to obtain a high photon flux. In quantitative studies, especially where multiple tracers are used simultaneously, the ability to record only photopeak counts is important. Also, pre-

cise organ delineation is necessary. Both of these requirements are met by the Ge(Li) detector. For clinical imaging of radioisotopes in humans, the role of semiconductor detectors is less well defined. When Ge(Li) detectors are compared with NaI(Tl) detectors on an equal-statistics basis, higher-quality images can be obtained with the Ge(Li) detectors. A question that remains to be answered is whether Ge(Li) detectors can compete with NaI(Tl) detectors on a sensitivity and cost basis. The sensitivity problem can be solved by making larger detectors or by using small detectors in arrays. The array concept has considerable merit in that one can take advantage of the excellent energy resolution of the small detectors and also use small, high-spatial-resolution collimators, both of which lead to improvement in the quality of the image. Semiconductors should be useful for bone-density measurements in calcium quantification studies. Organ-position determination, by combined transmission and emission studies, is a promising application. For fluorescence studies, semiconductor detectors are the only suitable detection systems. Scans which provide a map of the total iodine content of the thyroid gland can be obtained in a relatively short time with low radiation exposure to the patient. Semiconductor detectors should also be useful in obtaining improved emission scans with low-energy isotopes. The usefulness of such detectors for blood flow studies remains to be proved. (20 figures, 3 tables) (R.W.R.)

12018 CHARGE COUPLING; AN ALL ELECTRONIC APPROACH TO POSITION SENSITIVE PARTICLE DETECTION. Gordon, E. I. (Bell Telephone Labs., Murray Hill, NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 190-5(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A review of the workings of charge-coupled devices is given with the intention of bringing out the essential features and characteristics essential to understanding their capabilities and limitations as analog shift registers and imaging devices. While attention is focused on three-phase devices, some attention is given to two- and four-phase devices as well as the bucket brigade devices. The special advantages of these devices as contrasted with existing imaging devices are discussed. (4 figures) (auth)

12019 HYBRID APPROACH TO TWO DIMENSIONAL CHARGED PARTICLE POSITION SENSING PRESERVING ENERGY RESOLUTION. Augustyniak, W. M.; Brown, W. L.; Lie, H. P. (Bell Telephone Labs., Murray Hill, NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 196-200(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

By utilizing the secondary electrons, which are produced when an energetic charged particle enters a semiconductor particle detector, it was found feasible to obtain two-dimensional information on particle position without compromising the energy resolution of the particle detector. The low-energy secondary electrons are transferred with spatial fidelity from their point of origin on the entrance face of the particle detector to an electron multiplier array (Bendix micro-channel plate) by means of a uniform magnetic field. The position of the output charge from the array is derived from signals in a resistive collector plate. (8 figures) (auth)

12020 MULTI-CRYSTAL POSITRON CAMERA. Burnham, C. A.; Brownell, G. L. (Massachusetts General Hospital, Boston). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 201-5(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A multicrystal positron camera designed for use with radionuclides produced with a medical cyclotron is described. The camera uses coincidence techniques for collimation by detecting the positron annihilation radiation. Typical radionuclides are ^{11}C, ^{13}N, and ^{15}O with half lives of 20, 10, and 2 minutes, respectively. The principal object of the design is to achieve a data rate capacity to 5×10^4 coincidence events per second, as well as high sensitivity and resolution. This will allow time sequential images of fractional second duration. Each of the camera's two identical detectors consists of a planar array of 127 small NaI(Tl) crystals viewed by an array of 72 phototubes. Timing signals are derived from the phototubes, and are subsequently used to identify 2549 crystal pairs. The coincidence data is stored in a magnetic-core memory and used for a local data display; alternatively, data may be transferred under program control to a PDP-9 computer. The sensitive field area is 27 cm × 30 cm, and the spatial resolution is less than 1 cm at the midplane. The camera is currently being used for a number of clinical applications. (10 figures) (auth)

12021 LIQUID XENON RADIOISOTOPE CAMERA. Zaklad, Haim; Derenzo, S. E.; Muller, R. A.; (and others) (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 206-13(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The increasing availability of short-lived gamma- and positron-emitting isotopes, coupled with the importance of dynamical studies and better imaging, has generated the need for an improved γ-ray camera. A new type of γ-ray camera is discussed which makes use of electron avalanches in liquid xenon. A configuration currently under development is shown. The successful operation of a liquid-xenon proportional counter has been reported. The liquid-xenon camera promises better spatial resolution and higher counting rate than the existing NaI(Tl) scintillation camera. The spatial resolution for γ rays is in principle limited only by the range of photoelectrons in liquid xenon, which is <0.2 mm for energies <1 MeV. A counting rate of 10^6 c/s or more appears possible. As a result of the better resolution and high counting rate capability, the definition of the picture is improved. In addition, the high counting rate capability makes possible dynamic studies which were previously unfeasible. Although the energy resolution with liquid xenon is expected to be superior to that of NaI, preliminary measurements show 17% fwhm for 279-keV γ's. Improvements are expected by using better geometry and smoother wire. (11 figures, 2 tables) (auth)

12022 COAXIAL Ge(Li) GAMMA-RAY CAMERA. Strauss, M. G.; Sherman, I. S. (Argonne National Lab., IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 219-25(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A γ-ray camera utilizing a position-sensitive coaxial Ge(Li) detector is described. Slots parallel to the detector axis are machined in the outer n-layer contact of the crystal to produce effectively independent pie-shaped sectors. The sector preamplifier–discriminator that is activated by a γ-ray interaction in the detector specifies the angular position of the interaction. The radial location of the interaction is determined by pulse-shape analysis of the signal from the common broad-band low-noise preamplifier connected to the p-core. Thus, with an appropriate collimator the spatial distribution of radiation intensities is determined in polar coordinates. Position signals corresponding to one or more selected γ-ray energies are stored in a small computer, which transforms the polar coordinates into cartesian coordinates and displays the image on an X–Y oscilloscope. Data pertaining to the position response of the detector and to regional variations in detector efficiency are presented. (6 figures) (auth)

12023 DEVELOPMENT OF VARIOUS CATHETER SEMICONDUCTOR RADIATION DETECTORS AND THEIR APPLICATION TO CLINICAL MEDICINE. Takayanagi, S. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan); Kobayashi, T.; Sugita, T.; Iio, M.; Sasaki, Y. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 226-36(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A catheter semiconductor radiation detector (CASRAD) probe which can be placed safely inside a human body for the measurement of beta-ray activity was developed. To fulfill specific requirements arising from medical purposes, the detector element of the CASRAD probe was a silicon p–n junction diode of single-ended coaxial structure, 2.3 mm in diameter and 1 to 4 mm long. Difficulties of electronic noise caused by vibration of a long cable approximately 120 cm in length was solved by using a subminiature noiseless coaxial cable. The overall noise level of the CASRAD probe at 20 V bias and 40°C is less than about 40-keV beta rays equivalent. Therefore, the probe can be used to detect beta rays from ^{14}C, ^{85}Kr, ^{32}P, etc., provided window thickness of the probe is chosen properly. The beta-ray sensitivity of a CASRAD probe type TCK-2 is about 5,000 cpm/μCi/ml of ^{32}P solution. The CASRAD probe type TCK-2 was used for hemodynamic studies including measurement of circulation time, detection of left-to-right intercardiac shunt, continuous measurement of cardiac output, and measurement of coronary blood flow. Pulmonary function also was studied by using a CASRAD probe with a collimator and ^{85}Kr as an indicator. Malignancies of various organs such as the esophagus, stomach, lung, uterus, and breast were diagnosed by means of ^{32}P and the CASRAD probe. (14 figures, 1 table) (auth)

12024 MEASUREMENT OF THE DISAPPEARANCE RATE OF ^{75}Se SODIUM SELENITE IN THE EYE OF THE RAT BY A CdTe MEDICAL PROBE. Meyer, E. (Univ. of Montreal); Martini, M.; Sternberg, J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 237-43(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

There are biochemical reasons to attribute a physiological importance to selenium compounds in the constituents of the eye. This could justify a clinical application of ^{75}Se in ophthalmology. Good accuracy and relatively simple technique can be achieved with the aid of a miniature probe capable of working at room temperature and reasonably sensitive to gamma rays in the 100 to 300 keV region. The performance of a commercial Si(Li) and an experimental CdTe probe was compared for the detection of ^{75}Se. A solution of ^{75}Se sodium selenite was applied dropwise onto the eye, and its disappearance rate was then measured with both the Si(Li) and CdTe probes. Because of the low atomic number of silicon, it was not possible to obtain significant results with the Si(Li) probe. On the other hand, the CdTe probe yielded a counting rate sufficiently high to obtain a measurement of the disappearance rate, even with low-level activities, in the range of the amounts applicable in clinical diagnosis. Moreover, the higher photoelectric efficiency of the CdTe probe lends itself to the identification and measurement of two or more gamma emitting radionuclides applied simultaneously. (9 figures, 1 table) (auth)

12025 IN VIVO SILICON DETECTORS, IN VIVO PREAMPLIFIERS AND THEIR APPLICATIONS. Friedland, S. S. (Solid State Radiations Inc., Los Angeles); Benary, Vili; Ewins, J. H.; Katzenstein, H. S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 244-51(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

An analysis of the conflicting parameters for the optimum design of semiconductor detector and for use in vivo was made. Two forms of each were developed for use in many medical and biological applications. One is a bullet-shaped probe which permits shielding of the voltage-signal lead and operation at ground potential of all exposed surfaces; devices of 7 mm down to 3 mm diameter were made. The other is a plane-parallel device which must be used when the application demands that one or more dimensions must be in the range of 1 mm. The preamplifiers have dimensions of 1 mm diameter and 5 mm length and 3 mm diameter and 7 mm length. The physical and nuclear characteristics of each are presented with results of their application. (12 figures) (auth)

12026 ANALYSIS OF CdTe PROBES. Zanio, K.; Akutagawa, W.; Montano, H. (Hughes Research Labs., Malibu, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 257-62(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Probes were fabricated from semi-insulating CdTe, and their efficiency for photoevents, compared with silicon devices of similar active volumes ($\approx$6 mm^3). CdTe probes were found to be 150 times more efficient for 122-keV photons and about an order of magnitude more efficient for 60-keV x-rays. The resolution (fwhm) for probes was limited to $\approx$15 keV by cable capacitance at lower photon energies and at higher energies by the escape of the photoelectron from the active volume. For uncapsulated devices of comparable active volumes 8 keV and 10 keV resolution was obtained for ^{241}Am and ^{57}Co. For 50-mm^3 devices, resolutions of 5% were obtained for ^{137}Cs and ^{60}Co, and peak-to-total ratios were comparable to (^{137}Cs) and smaller than (^{60}Co) the ratio of the photoelectric to total absorption coefficients. The photoelectric absorption coefficient was measured for CdTe at 122 keV and found to be 5.4 ± 0.4 cm^{-1}. Theoretical spectra were computed and were in only qualitative agreement with experimental results. (7 figures) (auth)

12027 CHARACTERIZATION OF PURE GERMANIUM FOR DETECTOR FABRICATION. Hall, R. N. (General Electric Corporate Research and Development, Schenectady, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 266-70(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Germanium crystals grown in wet H_2 from material that contains trace amounts of silicon exhibit "smooth pits" in addition to familiar dislocation pits seen on etched surfaces. Such material appears normal by the usual methods of electrical evaluation, but detectors fabricated from it invariably exhibit severe trapping. Experiments yielding information about the presence of oxygen and silicon in germanium are reported. Preliminary observations indicate that a test for the presence of smooth pits may also provide a critical means for evaluating Li-drift material. Examination of a sample of "good" Li-drift germanium showed it to be free of these pits, whereas a sample described as "Drifts normally, but detectors show severe hole trapping." was found to have 700/cm^2 smooth pits. (4 figures, 1 table) (auth)

12028 EVALUATION OF HIGH-PURITY GERMANIUM BY PULSE MEASUREMENTS ON DETECTORS. Haller, E. E.; Hansen, W. L.; Goulding, F. S. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 271-4(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Evaluation of high-purity germanium exhibiting acceptor concentrations in the 10^9 to 10^{10}/cm^3 range taxes normal methods of measuring semiconductor material parameters. It has proven difficult to obtain unambiguous measurements by the Hall Effect or conductivity methods. It is shown that pulse measurements on guard-ring radiation detectors fabricated from high-purity germanium, when properly interpreted, can provide data on acceptor and hole concentrations as a function of temperature that supplement data obtained by Hall Effect and conductivity methods. The method, which is an extension of the technique used for detector capacity measurements, employs injection of electrical pulses via the detector into a charge-sensitive preamplifier. The shape and size of the output pulse permits determination of the characteristics of the depleted and undepleted regions of the detector; variation of the applied detector voltage allows choice of the relative thickness of the two regions. Results of measurements on two germanium crystals, over a broad temperature range, are presented. (8 figures) (auth)

12029 FURTHER STUDIES ON IMPLANTED HIGH PURITY GERMANIUM DETECTORS. Ponpon, J. P. (CRN, Strasbourg); Stuck, R.; Siffert, P.; Herzer, H.; Kalbitzer, S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 281-8(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Ion implantation and glow discharge methods were utilized to produce boron rectifying contacts on high-purity n-type germanium. The behavior of both kinds of contact are discussed with respect to the damage density and annealing as measured by electrical and backscattering properties. Ohmic contacts were obtained by phosphorus implantation, lithium diffusion, and metal evaporation. The counters were investigated with nuclear radiations (α, β, γ). (14 figures, 2 tables) (auth)

12030 HIGH OPERATING TEMPERATURE LIMITATIONS FOR GERMANIUM DETECTORS. Armantrout, G. A. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 289-98(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The operation of germanium spectrometers at temperatures considerably in excess of 77°K (with attendant advantages in the cooling system) has been made possible with the advent of high-purity germanium. The basic limitations on operating temperature are due to increased trapping effects and increased electronic noise. An extensive analysis was made of temperature-dependent noise sources. The principal limitation is due to trap and band-to-band bulk-generated currents. Experimentally determined parameters for germanium indicate that the operation of larger-volume detectors at temperatures in excess of 200°K is feasible. Several high-purity detectors (1 cm^3 and 14 cm^3 in volume) already were operated satisfactorily in the 170 to 180°K range, considerably higher than the 130 to 140°K maximum range observed for Ge(Li) detectors. In all detectors tested thus far, the principal limitation was due to trap-generated current; this finding indicates the possibility of further improvement. (15 figures) (auth)

12031 INFLUENCE OF SELECTED CHEMICAL IMPURITIES ON THE TRAPPING PARAMETERS OF Ge(Li) COUNTERS. Henck, R. (CRN, Strasbourg); Stuck, R.; Siffert, P.; Schoenmaekers, W. K.; De Laet, L. H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 299-305(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Specially grown p-type Ge crystals containing controlled quantities of various deep-level impurities were studied. Measurements of the dependence of the recombination lifetimes on temperature in the p-type samples were used to determine the level position and the capture cross section of the impurities. The trap parameters in n–i–p diodes were determined using a collimated beam of γ rays. Results are given for the following impurities: Ag, Cu, Zn, Cd, Cr, Te, Fe, Co, and Pt. These impurities were examined in crystals with and without dislocations. (6 figures, 2 tables) (auth)

12032 PROPERTIES OF ION-IMPLANTED SILICON DETECTORS. Zulliger, H. R.; Drummond, W. E.; Middleman, L. M. (Nuclear Semiconductor, Menlo Park, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 306-11(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Characteristic properties of ion-implanted radiation detectors are discussed. The detectors were fabricated in the following manner: Slices of high-purity n-type Si were implanted on both sides. The p^+ side was formed with implanted B ions accelerated to 10 keV, and the n^+ side was implanted with 10-keV P ions. After the ion implantation the detectors were annealed, and Al contacts were evaporated on both sides. The following parameters of the ion-implanted particle detectors were determined: entrance window thickness and back contact thickness, energy resolution for alpha particles and electrons, depletion voltage, electric field profile, and electron drift velocities as a function of electric field. It was found that ion-implanted detectors can be produced to have very thin entrance windows and thin back contacts. Furthermore, the energy resolution for alphas and electrons compares favorably with that of state-of-the-art surface-barrier and diffused-junction detectors. Ion-implanted detectors are also well suited as samples to study Si material properties and ion implantation physics. (10 figures, 2 tables) (R.W.R.)

12033 TIME-RESOLVED X-RAY DETECTION USING MOS-C DETECTORS. Kalibjian, R.; Ciarlo, D.; Mayeda, K.; Boster, T. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 339-45(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

To develop a fast x-ray detector with a memory, experiments with metal-oxide-semiconductor capacitor (MOS-C) devices were performed. For time-resolved recording of the x-ray pulse, a linear array of detectors was uniformly irradiated while the elements were sequentially biased at Δt time intervals; significant positive charge trapping occurred in each element of the array only during the period Δt when the high field bias was applied across the dielectric. Detection of 10-ns resolution was recorded. Time resolution is presently limited by the bandwidth limitation of the bias strobing method. (11 figures) (auth)

12034 WAYS OF PERFORMANCE IMPROVEMENT OF RADIATION-TYPE GERMANIUM DETECTORS. Strokan, N. B.; Eryomin, V. K.; Subashieva, V. P.; Tisnek, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 362-4(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Results on the resolution of radiation detectors are analyzed. It is pointed out that resolution is limited by hole trapping on deep centers, that compensates initial conductivity. This trapping can be lowered by electric fields exceeding the values 1.2 to 1.4 kV/cm, although the decrease of the background of impurities, that are present in Ge equally to chemical donors, is the more radical way. By this method one can get detectors with resolution better than 0.2% for 662-keV γ rays at donor concentrations of 10^{12} cm^{-3}. The resolution can be improved by the reduction of the inhomogeneous properties of monocrystals, which leads to a hole relaxation time in detectors up to 100%. (3 figures) (auth)

12035 EFFICIENCY INSTABILITY PROBLEM OF COAXIAL GERMANIUM DETECTORS. Wagner, S.; Trammell, R.; Walter, F. J. (ORTEC, Inc., Oak Ridge, TN). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 380-3(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The generally accepted belief in constant full-energy peak efficiency for coaxial germanium gamma-ray detectors maintained at liquid nitrogen temperature was found to be invalid in many cases. A majority of the available raw germanium ingots possess a shortcoming which causes detectors to decline in efficiency with time, if the standard techniques described in the literature have been employed for their production. A strong correlation of efficiency instability with ingot was established. The time rate of change varies markedly from ingot to ingot. Over 60% of the ingots studied resulted in detectors whose efficiencies declined at rates greater than 8% per year. A substantial fraction of the cases studied displayed relative decreases of 10 to 20% in a period of six months. Declines of as much as 10 to 25% in several weeks were also observed. (5 figures, 2 tables) (auth)

12036 SPACE CHARGE INFLUENCES ON FIELDS AND CHARGE COLLECTIONS IN HIGH PURITY GERMANIUM DETECTORS. Cho, Z. H.; Bohm, C.; Nylen, P. (Univ. of Stockholm). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 396-403(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Space charge influences on fields and charge collection properties in high-purity germanium coaxial and planar detectors are studied on the basis of the experimental results obtained by previous studies. Several different impurity charge densities ($N_A - N_D = 10^8$ to 10^{11} cm^{-3}) are considered with a nonconstant high field mobility, which was obtained by averaging the values obtained by several different investigators. A comparison with the lithium-drifted devices is given and a discussion relevant to the timing is presented. (7 figures) (auth)

12037 SOME PROBLEMS OF THE ALPHA-AUTORADIOGRAPHY WITH STRIPPING FILMS. Friemert, R.; Kraus, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Radioisotopy; 13: No. 3, 475-85(1972). (In German).

The properties of stripping films ORWO K 102, K 105, K 106 and Kodak AR 10 for the stripping film alpha-autoradiography have been investigated. The films were tested for reproducibility, linearity of the fluence dependence on the measuring efficiency, sensitivity, and fading properties. The exposed emulsions were evaluated by densitometry, and in the case of ORWO K 102 and Kodak AR 10 by densitometry and track counting in various ranges of fluence. The possibility of omitting the calibration of the films with standard sources is discussed. (auth)

12038 SUPPRESSION OF FOGGING IN PROLONGED EXPOSURES OF STRIPPING FILMS. Kraus, W.; Giese, B. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Radioisotopy; 13: No. 3, 487-95(1972). (In German).

Fogging in prolonged exposures was reduced on autoradiographic stripping films ORWO K 105, ORWO K 106 and Kodak AR 10. According to the first method the films are exposed at low temperatures (4°C) and low air humidity (use of desiccatives in the exposure box). The second method involves the addition of 10 $mg \cdot l^{-1}$ KBr + 5% glucose to the water bath for the washing of the films, as suggested by O'CALLAGHAN, STEVENS and WOOD. The fogging can be efficiently suppressed by both methods with maintained sensitivity of the films. Best results are obtained when combining the two methods. (auth)

12039 ELECTRON MICROSCOPE AUTORADIOGRAPHY: POSSIBLE ERRORS AND ARTIFACTS. Paul, D.; Groebe, A. (Institut fuer Faserstoff-Forschung, Teltow, Ger.). Radioisotopy; 13: No. 3, 497-513(1972). (In German).

Electron microscope autoradiography enables one to localize the radioactive radiation sources in fine structures of objects. The costly preparation involves also numerous sources of errors. These result in artifacts in the electron microscope image and reduce the obtainable information or lead to misinterpretations. Following the individual steps of the autoradiogram preparation, the errors and resulting artifacts are demonstrated on autoradiograms. The preparation of objects is mentioned only in brief. (auth)

12040 SOME SPECIAL EXPERIMENTAL FEATURES OF NEW AUTORADIOGRAPHY APPLICATIONS IN THE CENTRAL INSTITUTE FOR ISOTOPE AND RADIATION RESEARCH, LEIPZIG. Baumbach, H.; Hartmann, G.; Freyer, K.; Flachowsky, J.; Treutler, H.-Ch. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Berlin). Radioisotopy; 13: No. 3, 569-80(1972). (In German).

The general aspects of autoradiographic problem solutions as exemplified in the investigations of semiconductor materials, lacquer layers on concrete, and of cooking liquor distribution in wood samples are discussed. Special experimental features are stressed such as the influence of interfering quantities, combinations of techniques (radiometry, gamma-spectrometry, radiochemical and chemical analysis, ellipsometry, and autoradiography), experimental arrangements, choice of the nuclide for the visualization of interesting structures, double labelling techniques, etc. (auth)

12041 METHODS FOR IMPROVING RADIOGRAMS IN PLASTIC DETECTORS. Somogyi, G.; Gulyas, J. (Inst. of Nuclear Research, Debrecen, Hungary). Radioisotopy; 13: No. 3, 549-68 (1972).

Experiences relating to the improvement of the quality and evaluation of autoradiograms using plastic track detectors are described. The effect of some parameters (etching condition, ozone atmosphere) on track contrast was studied. A spark discharge method was applied to the evaluation of radiograms of samples containing fissile atoms. (auth)

12042 WIDE RANGE RATEMETER. Clausen, K. (Institut fuer Strahlenschutz, Stohl, Ger.). Kerntechnik; 14: No. 9, 395-7(Sep 1972). (In German and English).

The design of a radiation ratemeter which measures over a range of 6 decades without switching over is described. The measured data are displayed on a three-digit display as a floating decimal point number, and are also available at a plotter output as on analog DC voltage on a logarithmic scale. (auth)

12043 QUICK METHOD TO CHECK THE BIOLOGICAL DISTRIBUTION OF RADIOACTIVE PARTICLES. Kutas, Vera; Krasznai, I.; Kocsar, L. Int. J. Appl. Radiat. Isotop.; 23: No. 10, 469-70(Oct 1972). (In German).

The reliable checking of the distribution of isotope-labelled protein particles in the various organs furnishes important information about the quality of the product. This checking can be performed quickly and reliably by the spark chamber. (auth)

12044 COMPUTER SIMULATION OF THE PERFORMANCE OF A SPARK CHAMBER GAMMA CAMERA. De Lima, J. J. P.; Pullan, B. R. (Univ. of Manchester, Eng.). Phys. Med. Biol.; 17: No. 6, 823-9(Nov 1972).

The response of a spark chamber gamma camera to three-dimensional test objects has been simulated in a computer. The simulation was based on efficiency and point response function measurements for single parallel hole collimators using a Geiger counter as the detector. Measurements and simulations were also done using an NaI scintillation detector. A comparison of the two simulations shows that the product of activity in test objects and exposure time for the spark chamber system is of the order of 1000 times that for an NaI scintillation detector for the same visualization statistics. This results from the spark chamber's low detection efficiency and a loss of contrast caused by an inability to discriminate against scattered radiation. (auth)

12045 UNIFORMITY OF GAMMA CAMERAS. Macey, D. J. (Churchill Hospital, Oxford). Phys. Med. Biol.; 17: No. 6, 857-8(Nov 1972).

The relation between uniformity of an NE Mk IV gamma camera and the field size is plotted over a field range of 0 to 6 cm. Uniformity was defined as equal to $\frac{1}{2}$ (N max − min)/N mean × 100, where M max = maximum counts/field element, N min = minimum counts/field element, and M mean = mean counts/field element. The γ camera image for a uniform source of 2 mCi ^{131}I was recorded digitally in the 64 × 64 matrix of a Laben 4096 channel MCA, within a 26 cm dia. circle of the crystal. The specification of ±10% uniformity was approached only for a field element greater than 4 × 4 cm. (UK)

12046 1972 THIRTEENTH SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIUM, WASHINGTON, DC, MARCH 1-3, 1972. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 1-459(Jun 1972). (CONF-720306).

Separate abstracts were prepared for 68 of the 70 papers presented at this symposium. The remaining two, entitled "Single Photon Detection and Timing in the Lunar Laser Ranging Experiment" and "A Data-Gathering System for Studying Underwater Light and Bioluminescence," were not in the subject scope of NSA. (R.W.R.)

For abstracts of individual papers see: 11705, 12010–12036, 12047, 12110, 12126–12138, 12155–12162, 12203, 12204, 12220–12229, 12258, 12382, 12593, 12633, and 12993.

12047 ASPECTS OF IMAGING AND COUNTING IN NUCLEAR MEDICINE USING SCINTILLATION AND SEMICONDUCTOR DETECTORS. Beck, R. N.; Zimmer, L. T.; Charleston, D. B.; Hoffer, P. B. (Univ. of Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 173-8(Jun 1972).

From thirteenth scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

In the interest of minimizing patient irradiation while maximizing diagnostic image quality, it is desirable to utilize all of the radiation emerging from the patient. For optimum utilization it appears to be necessary to allow photons with different energies to contribute to the image with different weights. Optimum weights were determined for the most common case of noise-limited images, where it is assumed that the weights should be chosen so as to maximize the signal-to-noise ratio. For less noisy images, sharpening may be achieved by assigning negative weights to scattered photons; that is, by scatter subtraction. In general, image formation with multiple weighted channels provides a greater degree of flexibility than is possible with a single channel. (auth) (9 figures)

12048 CHERENKOV RADIATION IN PHOTOMULTIPLIER WINDOWS AND THE RESULTING TIME SHIFT IN DELAYED COINCIDENCE TIME SPECTRA. Roodbergen, S.; Kroondijk, R.; Verheul, H. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods; 105: No. 3, 551-5(1972).

Pulses from bare photomultipliers, irradiated by γ rays, are attributed to Cherenkov radiation induced by Compton electrons. Due to this effect certain time spectra of delayed coincidences, measured with scintillators mounted on photomultipliers, consist of two components. In addition to the normal spectrum, a weak spectrum, shifted with respect to the first one, is observed. This spectrum consists of delayed coincidences between the pulse due to a γ ray detected in a scintillator and the pulse due to the other γ ray, which was detected by the Cherenkov effect in the window of the photomultiplier. A possible systematic error in lifetime measurements caused by this effect is indicated, and a method to discriminate against this component in the time spectrum is described. The time resolution obtainable by using this Cherenkov radiation is discussed. (5 figures) (auth)

12049 FAST ANALOGUE PARTICLE IDENTIFICATION SYSTEM. England, J. B. A. (Australian National Univ., Canberra). Nucl. Instrum. Methods; 106: No. 1, 45-59(1973).

An analog particle identifier is described which uses a four-quadrant integrated-circuit multiplier. The identification function generated in this identifier is based on the Bethe–Bloch energy-loss formula. The output is produced with an overall delay in the region of 120 ns. The input pulses are standard RC-shaped monopolar pulses, and the output pulses are positive monopolar and positive-leading bipolar. The time jitter introduced by the circuit as measured at the zero-crossing point of the bipolar output pulse is less than 10 ns fwhm. The dynamic range of the circuit is from 2 MeV to 110 MeV, and is covered by two forms of the identification function. Measurements with charged-particle beams are presented to illustrate the operation of the system. (9 figures, 4 tables) (auth)

12050 PORTABLE MONITOR FOR TRITUM IN AIR. Osborne, R. V.; Coveart, A. S. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 106: No. 1, 181-7 (1973).

From 5 to 10^7 $\mu Ci/m^3$ may be measured with the 1330-cm^3 ionization chamber and solid state electrometer. Readout is in MPC_a for tritiated water vapor. Compensation for gamma background irradiation from any direction is greater than 95%. The overall response time constant is 70s with an air flow rate of 30 cm^3/s provided by the associated portable pump. Electrometer batteries last several months. The monitor, including the pump, weighs 5.7 kg. An internal beta source is provided for checking calibration and air flow. (11 figures) (auth)

12051 TIMING CIRCUIT FOR Ge(Li) DETECTORS. Karlsson, L. (Royal Veterinary and Agricultural Univ., Copenhagen). Nucl. Instrum. Methods; 106: No. 1, 161-9(1973).

A timing circuit suited for deriving time information from Si and Ge(Li) detectors is presented. Problems adhering to the use of high-speed emitter-coupled logic circuits as time decision and memory elements are considered. Results obtained with this timing circuit in conjunction with a 20-cm^3 coaxial Ge(Li) detector are presented. (11 figures) (auth)

12052 MULTI-BRANCH VALVE FOR HIGH VACUUM SYSTEMS. Franke, H. F. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 106: No. 1, 13-14(1973). (In German).

A multi-branch high-vacuum valve is described. (2 figures) (auth)

12053 ACCURATE MEASUREMENT OF THE COUNTING EFFICIENCY OF A NE-213 NEUTRON DETECTOR BETWEEN 2 AND 26 MeV. Drosg, M. (Los Alamos Scientific Lab., NM). Nucl. Instrum. Methods; 105: No. 3, 573-84(1972).

The neutron detection efficiency of a liquid scintillator (NE-213, 12 cm dia × 5.7 cm) was measured with various bias settings corresponding to proton energies from 1 MeV to 6 MeV. For neutron energies below about 12 MeV a simplified calculation fits the data very well, and the uncertainty in the shape is less than 2%. The importance of contributions from the reaction $^{12}C(n,n')$ 3α above that energy is shown. An extensive survey of publications dealing with the efficiency of organic scintillators is also presented. (7 figures, 3 tables, 62 references) (auth)

12054 SIMPLE DEVICE FOR TRACK COUNTING IN NUCLEAR EMULSIONS. Malaroda, R.; Zecchin, G. (Univ., Trieste, Italy). Nucl. Instrum. Methods; 105: No. 3, 597-8 (1972).

A scanning device for track counting in nuclear emulsions of the type used in a magnetic spectrograph was experimentally tested. It consists of an optical microscopic scanner, which projects the enlarged track through an analyzing fixed slit to a photomultiplier tube, which supplies an electric pulse to a counter. If the photographic emulsion faults are overlooked, the counting efficiency of the system is of the order of 93% for tracks parallel to the slit or inclined less than ±4°. (1 figure, 1 table) (auth)

12055 DEMOUNTABLE HIGH VACUUM TIGHT HIGH VOLTAGE FEEDTHROUGH. Franke, H. F. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 105: No. 3, 601(1972). (In German).

A demountable high-vacuum-tight high-voltage feedthrough for Ge-detector cryostats is described. (1 figure) (auth)

12056 ASSESSMENT OF A MOTT-SCHWINGER SCATTERING POLARIMETER FOR NEUTRONS OF A FEW MeV ENERGY.

Galloway, R. B.; Masyouf, R. M. A. (Univ. of Edinburgh). Nucl. Instrum. Methods; 105: No. 3, 561-4(1972).

A polarimeter for neutrons of a few MeV energy, which employs elastic scattering by lead through an angle of about 2°, is described; and the efficiency of data collection and the accuracy attainable are discussed. A comparison is presented with a typical polarimeter relying on scattering by ^{4}He. Data obtained with the ^{2}H(d,n)^{3}He reaction for a mean deuteron energy of 575 keV illustrate the properties of the system. It is concluded that a polarimeter based on small-angle scattering could compare in efficiency of data collection with a system employing scattering by high pressure ^{4}He gas, and could avoid the systematic error possible with a ^{4}He system. (2 figures, 1 table) (auth)

12057 ELECTROSTATIC PROBLEMS IN MULTIWIRE PROPORTIONAL CHAMBERS. Erskine, G. A. (CERN, Geneva). Nucl. Instrum. Methods; 105: No. 3, 565-72(1972).

With the known complex potential of an infinite grid of thin wires lying between parallel grounded electrodes as a basis, the following problems are discussed: the electrostatic coupling between wires, the effect of varying the diameter of a single wire, and the effect of displacing a single wire. Figures are given which show the magnitude of these effects for a symmetric chamber of arbitrary dimensions. The computer generation of field plots for proportional chambers is briefly discussed. (8 figures) (auth)

12058 REVERSAL AUTORADIOGRAPHY: A METHOD FOR THE EXAMINATION OF SMALL RADIOACTIVE PARTICLES. Sisefsky, J. (Foersvarets Forskningsanstalt, Stockholm). J. Phys., E (London); 6: No. 1, 74-6(Jan 1973).

An improved method for the autoradiographic examination of small radioactive particles is described. The particles are identified under the microscope among accompanying inactive ones by their being surrounded by clear circular spots against a colored transparent background, thus enabling an undisturbed examination of the particles. The activity of individual particles can be estimated from the diameter of the clear spots. (auth)

12059 COMPARISON OF THE IDENTIFICATION METHODS FOR MEASURING HEAVILY CHARGED PARTICLES. Miyajima, Mitsuhiro (Inst. of Physical and Chemical Research, Wako, Japan). Oyo Butsuri; 41: No. 3, 290-9(Mar 1972). (In Japanese).

The technique of heavy-ion-nuclide discrimination with radiation detectors has become important with the progress of heavy ion accelerators and the studies of heavily charged particles in cosmic ray research. A brief discussion of their principles and an intercomparison of accuracy are given. Telescopes of the penetrating type and the dE/dx-E type using semiconductor detectors, scintillation detectors, and Cherenkov detectors; nuclear emulsions; and solid-state track detectors are discussed. The accuracies for particle discrimination are shown in tables, indicating that semiconductor detectors are best. However, long term measurement is required for them because it is difficult to manufacture large area detectors. Nuclear emulsions have the advantage that they may be observed at any time once they are developed, though they show fading of latent images and contraction before the developing. They are also expensive. The solid-state track detectors are not influenced by background, but often show the fading of latent images and sometimes the material is not homogeneous. (Japan)

12060 SENSITIVITY OF A SCINTILLATION COUNTER FOR THE MEASUREMENT OF RADIOACTIVITY IN THE BODY. Koshijima, Tokusaburo; Kono, Soji (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri; 7: No. 2, 79-83 (Jun 1972). (In Japanese).

The minimum detectable body radioactivity, the relation between the detection efficiency and source to detector distance, state of sources, dependence of detection limit on γ-ray energy, and influence of the variation of background level are studied with a simple scintillation counter widely used in radiation facilities. The results show that most γ-emitting nuclides of 0.1 μCi are detectable by a simple scintillation counter in a room without special shielding. The effect of the collimating shield of the detector on the detection limit and the relation between the optimum counting condition and the background level are discussed. (auth)

12061 CHARGE SENSITIVE PREAMPLIFIER (Engineering Materials). (Los Alamos Scientific Lab., NM). (CAPE-2295).

4 drawings.

12062 SCINTILLATION CAMERA HAVING A VARIABLE GAIN PLURAL AMPLIFIER SYSTEM. Martone, R. J.; Mueller, P. G. (to Picker Corp.). U. S. Patent 3,697,753. 10 Oct 1972. Filed 18 Jun 1969.

A scintillation camera system is disclosed having a scintillator camera which produces electrical signals corresponding to scintillation intensity and location on a scintillator. The system has circuitry for processing these signals including a plurality of signal amplifiers which individually amplify the intensity and locate the signals. The gain of these signal amplifiers is adjustable by a remote switch which alters the condition of gain control circuitry associated with the signal amplifiers. The disclosed signal amplifiers further include a control circuit which stabilizes the direct current (D.C.) output of the amplifiers at a particular level with respect to a reference voltage and yet permits output pulses to be produced without altering the output pulse amplitudes. (auth)

12063 RADIATION DETECTOR. Meuleman, Johannes; Aussant, Michel (to U. S. Philips Corp.). U. S. Patent 3,697,825. 10 Oct 1972. Priority date 26 Jan 1970, France.

A method of connecting a semiconductor crystal of a radiation detector to a support, for example, a Ge(Li) detector, in which the support is constructed with a connection part the shape of which is adapted to a circumferential connection surface which is present on a side face or in a cavity of the crystal is described. Prior to the connection, the connection part of the support is brought to a temperature which differs from the operating temperature of the radiation detector, after which the support and the crystal are slid one into the other until the connection part of the support is located opposite to the connection surface of the crystal. The support is then brought to the operating temperature of the detector and the crystal is connected to the support in a clamping manner. (auth)

12064 SCINTILLATION RECORDING DEVICE FOR PRODUCING BOTH BLACK AND WHITE AND MULTI-COLOR PHOTOGRAPHIC RECORDS. Brunnett, C. J.; Payne, D. C. (to Picker Corp.). U. S. Patent 3,683,184. 8 Aug 1972. 15 Aug 1967.

The output of a scintillation probe is connected to energize one or more level discriminators, which respond to different levels of radioactivity detected. Each level discriminator is connected to permit energization of a different colored light source, the light from which exposes a color-sensitive photographic film. The system is designed for radioisotope scanning. (auth)

12065 NOTE ON LITHIUM-DRIFTED GERMANIUM GAMMA-RAY DETECTORS. Raeside, D. E. (Mankato State Coll., MN). Amer. J. Phys.; 40: No. 9, 1343-4(Sep 1972).

A method for determining the position of a coaxial Ge(Li) crystal in its cryostat and for determining the extent of the nonsensitive central core of a true coaxial Ge(Li) crystal is briefly described. The face of the Ge(Li) crystal is scanned with a narrow gamma beam. (W.H.K.)

12066 SCINTILLATION CAMERA WITH REMOVABLE SUBASSEMBLY. Martone, R. J.; Mueller, P. G.; Flis, R. J. (to Picker Corp.). U. S. Patent 3,683,180. 8 Aug 1972. Filed 16 Jun 1969.

A gamma imaging camera with a scintillation crystal and a plurality of phototubes is described. A light pipe optically couples the crystal and the tubes. The light pipe has, as its output end, a plurality of truncated pyramids each associated with one of the phototubes. As disclosed, the walls of the pyramids are hexagonal in cross-sectional configuration and flare outwardly to intersect adjacent walls, thus providing a continuous field of view. Also a lift-out detector head subassembly is described. (auth)

12067 RADIATION DETECTOR COMPRISING SEMI-CONDUCTOR BODY INCORPORATING A TWO-DIMENSIONAL ARRAY OF P-I-N-DEVICES. Ellis, Ronald; Wankling, J. L. U. S. Patent 3,691,389. 12 Sep 1972. Filed 9 Jun 1969.

A radiation detector comprising a slab of semiconductor material having a p-i-n structure with ribs formed on opposite sides of the slabs, in p-i and n-i junctions lying within the ribs is described. The ribs on one side of the slab are so aligned as to traverse those on the other side of the body. The detector is designed for use in a gamma camera. (auth)

12068 SCINTILLATION CAMERA DEVICE. Tanaka, Elichi; Hiramoto, Toshiyuki; Nohara, Norimasa (to National Inst. of Radiological Sciences). U. S. Patent 3,691,379. 12 Sep 1972. Priority date 1 Oct 1969, Japan.

A scintillation camera device wherein output pulse signals from photomultipliers optically coupled with a scintillator giving forth light upon absorption of radiation from a radioactive isotope taken into a foreground subject are supplied to a delay element such as a delay line for separating said output signals in time sequence so as to render them proportionate to the co-ordinate position of said photomultipliers. The output signals from the delay element are shaped into bipolar symmetrical waves in a double delay line type wave forming circuit in such a manner that the zero-crossing time of a composite of wave forms is obtained in accordance with the co-ordinate position of the scintillation point; and the zero-

crossing time of said composite wave form is converted to voltage, which is indicated on a cathode ray tube as the position of the scintillation point. (auth)

12069 MEANS OF CANCELLATION OF THE EFFECT OF RANDOM DEVIATIONS IN RADIOACTIVE EMISSION UPON AN ANALOG D.C. VOLTAGE. Garrett, S. W. (to Combustion Engineering, Inc.). U. S. Patent 3,683,189. 8 Aug 1972. Filed 13 Nov 1969.

A system is disclosed in which a source and detector of radiation are positioned to sense a physical property, the detector generating electrical pulses proportional to the energy of the source impinging thereupon. The circuitry of the system amplifies and shapes the pulses, converts them into an analog D.C. signal with A.C. components proportional to the frequency of the pulses, and amplifies the D.C. through A.C. and operational amplifiers to cancel the A.C. component and produce a pure analog D.C. output signal. (auth)

12070 TOMOGRAPHIC RADIATION SENSITIVE DEVICE. Miraldi. F. D. (to Case Western Reserve Univ.). U. S. Patent 3,688,113. 29 Aug 1972. Filed 22 Jun 1970.

A radioisotope device having a collimator delimits radiation from a source. A scintillation crystal having a rectangular cross-section and a generally elongated shape receives radiation after it passes through the collimator and changes it to visible light at each point. Photomultiplier tubes at each end of the scintillation crystal convert the light to electrical pulses. The amplitudes of electrical pulses are converted to logarithms of the amplitudes and summed. A pulse height selector chooses only the sums of those logarithms desired for observation. The logarithms of the amplitudes are also subtracted to find the location of the scintillation in the scintillation crystal. Means are also provided for moving the source of radiation relative to the collimator. A recording means stores information concerning the relative positions of the source and the collimator during the time radiation is received. Information from a plurality of scans allows a determination of a pattern of the radiation at different depths and areas within the source. It is also possible to use a plurality of collimators and scintillation crystals and a single scan to determine radiation patterns at multiple depths within the source. (auth)

12071 ANTICOINCIDENCE INSTALLATION FOR INTERNAL COUNTING COUNTER. Sirbu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 6, 769-71(1972). (In Rumanian).

An anticoincidence installation for an internal counting G–M counter is described. The installation is used for the determination of geological ages by means of the K/Ar method. (auth)

12072 WHOLE-BODY COUNTER EFFICIENCY CALCULATIONS IN A HUMAN PHANTOM. Andrasi, A.; Kotel, Gy. (MTA Kozponti Fizikai Kutato Intezete, Budapest). Izotoptechnika; 15: No. 6, 323-9(Jun 1972). (In Hungarian).

Empirical modelling of the whole energy peak efficiency of the Na(Tl) detector of a whole-body counter as a function of energy and spatial coordinates of point sources is studied, and the determination of the counter efficiency in the range of 0.1 to 2.0 MeV is discussed. The deviation of calculated and measured values amounts to ±4%. (auth)

12073 APPARATUS FOR NUCLEAR LEVEL LIFETIME MEASUREMENTS BY THE RECOIL DISTANCE DOPPLER-SHIFT METHOD. Bochev, B.; Karamyan, S. A.; Kutsarova, T.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Compt. Rend. Acad. Bulg. Sci.; 25: No. 7, 905-8(1972). (In Russian).

A chamber was designed with a Ge(Li) detector, diaphragm, target, grating, and a Bi stopper for measuring lifetimes of the order of 10^{-9} to 10^{-12} sec. The technique was based on the Doppler shift of gamma radiation from excited nuclei which generate a pulse recoil. A thin target moving in a vacuum and emitting gamma quanta manifests a Doppler shift in energy. The Bi stopper located near the target checks a portion of the nuclear recoils, and the Ge(Li) detector resolves two peaks, the relative intensity of which depends on the distance between the target and stopper, and furnishes the decay curve of the excited state. (K.S.W.)

12074 LOW ENERGY PARTICLE COUNTER WITH ONE-DIMENSIONAL POSITION SENSING. Somer, T. A. (to The Bendix Corp.). U. S. Patent 3,691,382. 12 Sep 1972. Filed 30 Oct 1970.

The invention provides one-dimensional position information relating to the detection of low energy particles such as photons or charged particles and also provides the capability of counting the detected particles. A particle detection device such as a spiraltron electron multiplier is combined with a linear resistor which splits the charge emanating from the detection device in a ratio which is proportional to the position of the charge on the linear resistor. An analog divider divides the proportional charge on the linear resistor into the output charge from the detection device to thereby yield an output indication which is independent of the statistically variable total charge emanating from the detection device. The output of the divider is, therefore, an indication of the position at which the charge emanated from the detection device, and also shows that a detected particle impacted the input end of the detector. Accordingly, the number of detectable charges which impinged upon the input end of the detector within a chosen period of time can be counted, and the positions at which they struck the detector can be recorded. (auth)

12075 UNFOLDING METHODS IN NEUTRON SPECTRA MEASUREMENTS BY FOIL ACTIVATION TECHNIQUE. Dierckx, R. (EURATOM-CCR, Ispra, Italy); Nimis, M. L.; Sangiust, V.; Terrani, M. Nucl. Instrum. Methods; 105: No. 1, 1-4(1972).

Two unfolding methods, SAND II and SPECTRA, were tested and compared. The experimental results obtained with nine threshold detectors irradiated in the center of the core of the L54 reactor were used as input data. The relative merits of the two methods are presented and discussed. (2 figures, 1 table) (auth)

12076 POSSIBLE MECHANISM OF TRACK RECORDING FROM IONIZING PARTICLES BY CELLULOSE FILMS. Veprik, Ya. M.; Kartuzhanskii, A. L.; Marennyi, A. M.; Popov, V. I. Zh. Nauch. Prikl. Fotogr. Kinematogr.; 17: No. 5, 349-53(1972). (In Russian).

The structure of the cellulose molecule and of its nitrate and acetate derivatives is discussed with particular reference to breaking of various bonds by particles of different energies (5 to 15 MeV). The sensitivity of polymeric detectors in the form of cellulose films is related to the ether linkages between the monomeric units and the replacement of OH groups by nitro groups and to a lesser degree, by acetate groups. The ability of some types of ruptured bonds to recombine, in contrast to other types of bonds which lead to an irreversible disjunction of the polymer, is examined. (K.S.W.)

12077 APPLICATION OF THE CAMPBELL METHOD TO NUCLEAR MEASUREMENTS. Schmidt, K. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 14: No. 9, 402-9(Sep 1972). (In German and English).

Campbell's mean square theorem for measuring the signal from an ionization chamber is discussed, and a block diagram of a Campbell channel is given and described. The use of Campbell circuits with fission ionization chambers is considered, and the good gamma discrimination characteristics are elaborated. Also, the cross-correlation method for reducing the noise of the amplifier and thus lowering the lower limit of the measuring range is discussed. (WHK)

12078 PROGRAMMING SYSTEM FOR MULTI-PARAMETER EXPERIMENTS AND ITS APPLICATION TO NUCLEAR BREMSSTRAHLUNG MEASUREMENTS. Mueller, R.; Peyer, U.; Woelfli, W.; Hall, J.; Suter, M. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Instrum. Methods; 104: No. 1, 125-30(1972).

A programming system has been developed for a medium-scale, on-line computer (PDP-15) in order to perform charged particle coincidence experiments with sub-ns time resolution. The application of this system to the study of nuclear bremsstrahlung reactions is described. (auth)

12079 COMPARISONS BETWEEN S71A AND S71D RESULTS FROM THE ESRO-I/AURORAE SATELLITE. Smith, P. A.; Thomas, G. R. ELDO/ESRO Sci. Tech. Rev.; 4: No. 2, 113-32 (1972).

Comparisons were made between the electron intensities obtained from two different experiments on the satellite Aurorae which were both designed to measure electrons with energies >40 keV. The study revealed a systematic disagreement between the results which is related to the softness of the spectrum being measured. The disagreement is attributed to differences in the low-energy thresholds of the two experiments. Detailed analysis of the low-energy responses is described and supporting evidence presented to show that in orbit, contrary to pre-launch conditions, the S71A experiment has a lower energy threshold than S71D. (France)

12080 X-RAY DETECTOR SYSTEM FOR INTERSTELLAR NEON ABUNDANCE DETERMINATION AND OXYGEN LINE EMISSION STRENGTH. Garmire, G. P.; Riegler, G. R.; Stevens, J. C. (California Inst. of Tech., Pasadena). pp 1517-22 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A balanced filter system employing a metallic sodium, Teflon (fluorine) and neon gas filter has been evaluated for sensitivity in determining the interstellar neon abundance. The absorption edge in the cosmic x-ray background produced by neon should provide neon abundance determinations for about six to ten directions in the galactic plane from an OSO-size spacecraft. A second filter system utilizing a Teflon and oxygen gas filter has been evaluated for determining oxygen line emission from cosmic x-ray sources. The minimum detectable line for a typical Aerobee flight is about 2×10^{-10} ergs/cm^2 sec, .04 of the estimated Cygnus Loop oxygen lines. (auth)

12081 GAMMA RAY EXPERIMENT FOR THE SMALL ASTRONOMY SATELLITE B (SAS-B). Fichtel, C. E.; Ehrmann, C. H.; Hartman, R. C.; (and others) (Goddard Space Flight Center, Greenbelt, MD). pp 1559-63 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A magnetic core digitized spark chamber gamma ray telescope has been developed for satellite use and will be flown on SAS-B in less than one year. The SAS-B detector will have the following characteristics: Effective area ≈ 500 cm^2, solid angle ≈ $\frac{1}{4}$ SR; Efficiency (high energy) ≈ 0.29; and time resolution of better than two milliseconds. A detailed picture of the galactic plane in gamma rays should be obtained with this experiment, and a study of point sources, including short bursts of gamma rays from supernovae explosions, will also be possible. (auth)

12082 TECHNIQUES OF MAGNET-EMULSION SPECTROMETRY. Golden, R. L. (Manned Spacecraft Center, Houston, TX); Adams, J. H.; Boykin, W. R.; (and others). pp 1577-82 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A balloon-borne rigidity spectrometer consisting of 5 emulsion coated glass sheets in a 1.5 kG-m magnetic field has been used to measure rigidities in excess of 300 GV. The spectrometer plates are 4″ × 6″ × 1.4 mm glass sheets which are coated on both sides with 100 μm of Kodak NTB-3 emulsion. The plates are spaced 1½″ apart in an average 10 kG field. Microscope measurements of the tracks are made with respect to three reference tracks. The daily variations in the reference track locations are used to compensate for changes in plate location on the microscope and orthogonality changes in the microscope. Measurements made under widely varying conditions are combined to determine sagittae to ~2 μm. Alignment of the plates is determined to ~2 μm by analyzing measurements of tracks which traverse the spectrometer while the magnet is off. Rigidities of the particles are determined by an iterative fitting procedure which involves the computation of trajectories through a nonuniform magnetic field. The rigidity detection technique is presented in detail together with a discussion of systematic errors, their sources, detection and elimination. (auth)

12083 EXPERIMENT TO STUDY THE NUCLEAR COMPONENT OF PRIMARY COSMIC RAYS. Paul, J. M.; Verma, S. D. (Louisiana State Univ., Baton Rouge). pp 1614-19 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

An apparatus has been designed and is being fabricated to study the charge composition, fluxes, and energy spectra of light nuclei ($Z \leq 8$) in the energy region from 1 GeV to 100 GeV. The apparatus essentially consists of an array of a large number of particle detectors operated in coincidence and serving as a charged particle telescope. A mosaic silicon semiconductor detector, a plastic scintillation counter and a Lucite Cherenkov detector are used to measure the charges of the incident nuclei. Two one-inch thick CsI(Tl) detectors are used to study low energy particles. An ionization spectrometer is utilized to measure primary energies in the 1 to 100 GeV energy interval. The spectrometer consists of alternating layers of tungsten absorber and plastic scintillator. A gas Cherenkov counter is being designed to distinguish between electrons and protons. It is planned to calibrate the apparatus at an accelerator using particles of known energy. The apparatus will be exposed at high altitudes using balloons launched from Palestine, Texas. Since the geomagnetic cutoff at Palestine is about 4.5 GV, only primary particles of higher rigidities will be studied. In the same experiment, re-entrant charged albedo particles will also be studied. (auth)

12084 USE OF LIGHT EMITTING DIODES IN THE TESTING OF PHOTOMULTIPLIERS. Bell, C. J.; Winn, M. M. (Univ. of Sydney). pp 1624-9 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The use of light emitting diodes in the testing of photomultipliers as used in scintillation counters is discussed. The results show that L.E.D.'s provide a simple way of testing both timing and light response. (auth)

12085 FAST-FILM CHERENKOV DETECTOR FOR COSMIC RAY PRIMARIES WITH $Z \geq 60$. Pinsky, L. S.; Eandi, R. D.; Osborne, W. Z.; Rushing, R. B. (Manned Spacecraft Center, Houston, TX). pp 1630-4 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 4).

A fast-film Cherenkov detector for energetic, extremely heavy nuclei has been tested in balloon flights of large area detector arrays which also included nuclear emulsions and plastic track detectors. A total exposure of roughly 2×10^3 m^2 hours has been accumulated at altitudes above 115,000 feet. The Cherenkov detectors are designed to provide velocity measurements for particles with $\beta \geq .67$ and $Z \geq 60$. From approximately 20 events found in the nuclear emulsion with estimated charges of at least 60, 9 have corresponding Cherenkov images. Many of those with no Cherenkov images appear in the nuclear emulsion to be slow, and no obviously fast particles have failed to yield Cherenkov images for estimated charges of at least 60. (auth)

12086 SEMIAUTOMATIC MICROSCOPE FOR HIGH-SPEED MEASUREMENT OF NUCLEAR EMULSIONS. Golden, R. L; Adams, J. H.; Boykin, W. R.; Neumann, W. R. (Manned Spacecraft Center, Houston, TX). pp 1637-42 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A PDP-8 computer is used to position the stage of a modified Bausch and Lomb microscope to a predetermined location with an accuracy of ~2 μm. An operator recognizes tracks and centers them on the cross hairs. Digitization is performed by the PDP-8 which writes track coordinates on magnetic tape. The system is being used to trace tracks through sets of emulsion plates which were exposed to cosmic rays while in the field of a superconducting magnet. The controlling program provides a number of data verification aids such as helping the operator remove backlash and checking the space angles of measured tracks. These aids have greatly reduced measurement errors. The operator views the tracks via a high resolution TV system. By proper adjustment of the contrast profile the TV image is found to be superior to the directly viewed image. In addition, the TV system is able to present larger viewing areas than the conventional direct-view system. (auth)

12087 LIGHT OUTPUT CONTROL OF A PULSED LIGHT SOURCE FOR USE IN STABILIZING SCINTILLATION DETECTORS. Yamashita, Mikio (Electrotechnical Lab., Tokyo). Rev. Sci. Instrum.; 43: No. 11, 1719-21(Nov 1972).

A method is described for controlling the light output of a pulsed light source so that a scintillation detector stabilizing system based on the pulsed light source would be able to compensate variations in the light output of the scintillator with temperature as well as other temperature dependent instabilities. (auth)

12088 CLEANING AND ACTIVATION OF BERYLLIUM-COPPER ELECTRON MULTIPLIER DYNODES. Pongratz, Morris B. (Univ. of Maryland, College Park). Rev. Sci. Instrum.; 43: No. 11, 1714-15(Nov 1972).

The cleaning and activation procedure followed in preparing beryllium-copper dynodes for electron multipliers used in sounding rocket experiments to detect auroral electrons is described. (auth)

12089 POSITION SENSITIVE PROPORTIONAL DETECTOR FOR X-RAY CRYSTALLOGRAPHY. Gabriel, A.; Dupont, Y. (Institut des Sciences Nucleaires, Grenoble, France). Rev. Sci. Instrum.; 43: No. 11, 1600-2(Nov 1972).

A position sensitive proportional detector applied to x-ray low angle scattering is described with emphasis on its performance in the biological field, where the time element is of great importance. Spatial resolutions of 160 μ have been obtained for counting rates up to 3×10^5 counts per second. Owing to this performance and to a quantum efficiency that can reach 100%, this detector can replace with advantage the x-ray film used so far for a great number of experiments. (auth)

12090 PREPARATION AND CHARACTERISTICS OF A CHANNEL ELECTRON MULTIPLIER. Becker, H.; Dietz, E.; Gerhardt, U. (Univ., Frankfurt am Main). Rev. Sci. Instrum.; 43: No. 11, 1587-9(Nov 1972).

Channel electron multipliers are prepared from appropriately shaped glass tubing with an inner coating consisting of a glass which contains 60% Bi_2O_3. Heat treatment of the device in a hydrogen atmosphere at 470°C produces a conductive coating inside the tubing. The pulse height distribution of the multipliers narrows drastically with increasing operating voltage; its full width at half-maximum being about 10%–30% at a gain of about 10^8. The dark count rate is typically below 0.01 counts/sec. A simple trigger circuit which converts the multiplier pulses into TTL compatible digital pulses is provided. The quantum efficiency of the conductive coating for low energy electrons is nearly unity. The multiplier responds to photons with energies as low as 5 eV. The quantum yield increases up to values of about 10^{-2} for 10 eV photons if the conductive coating at the cathode is covered with a thin CsI layer. (auth)

12091 SCATTERHOLE CAMERA AND METHOD FOR USING SAME INCLUDING THE STEP OF CONVOLUTING THE IMAGE. Dicke, R. H. (to Research Corp.). U. S. Patent 3,700,895. 24 Oct 1972. Filed 14 Aug 1969.

An apparatus and method useful for recording high resolution images of radiation, such as from X-ray or gamma ray-emitting objects, is described. The apparatus comprises the use of an entrance plate having a number of randomly distributed pinholes which pass the impinging rays from the radiating objects, casting a number of overlapping images of the pinhole pattern on a sensing plate, which may be in the form of a photographic film, spark chamber or other readout or recording means. A comparison of the pinhole pattern with the overlapping image pattern by evaluating their convolution integral, which may be accomplished by one or more optical methods, such as passing radiation through the two patterns as they are successively shifted with respect to each other, or digitally on a computer will provide a high resolution reconstruction of the pattern of the radiation sources in the object field. (auth)

12092 GASEOUS CHERENKOV THRESHOLD GAMMA RAY DETECTOR AS A REACTOR POWER MONITOR. Humphries, J. R. Ann Arbor, MI; Univ. of Michigan (1972). 178p. University Microfilms Order No. 72-29,096.

Thesis.

Rapid, precise, and dependable determination of operating power level is essential for nuclear reactor operation and safety. A major problem to be overcome in making such a power measurement, however, is to differentiate between the power-related and non-power-related variables. In this context, the power-related variable includes the neutrons or the prompt gamma rays emitted essentially simultaneously with fission and capture events. The non-power-related variable is the large flux of fission product decay radiation, which does not vary with instantaneous reactor power level. Because of the variable threshold level for the detection of gammas which is a characteristic of the gaseous Cherenkov threshold gamma ray detector, such a detector can make this differentiation on the basis of gamma energy. Thus, reactor power can be measured through the relatively high energy power-related prompt gammas while discriminating effectively against the lower energy delayed fission product decay gammas. A small diameter gaseous Cherenkov detector has been designed and developed for use as a reactor power monitor. A variety of measurements have been carried out in order to understand the operating characteristics of the detector and to evaluate its potential as a practical power monitoring instrument. In addition, a FORTRAN computer code has been developed to calculate the output current from the detector in order to allow a set of parametric studies of the effect of changes in the detector design and operating conditions to be made. The results of this work confirmed that a small diameter gaseous Cherenkov detector can be used effectively to measure reactor power over a wide range of power in the presence of a large background of fission product decay gammas. Selection of the proper radiator gas has been found to be one of the major factors in obtaining optimum detector performance. Although further work could well be spent in the evaluation and interpretation of the characteristics of potential radiator gases and in additional detector design studies, the gaseous Cherenkov detector in its present configuration has performance characteristics which equal or exceed those of the currently installed linear level power monitoring instrumentation. (Diss. Abstr. Int., B)

12093 PULSE FORM IN A RECTANGULAR IONIZATION CHAMBER. Mukhibi, G. S.; Kosarev, V. B.; Nechin, Yu. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 175-83 (1972). (In Russian).

Calculations were made on the potential pulse of an ionization chamber of rectangular shape; and the pulse amplitude from a single relativistic particle which intersected the chamber in a near-vertical direction was measured. The ratio of electron component of the ionized pulse to the total pulse $P_e/P_{total} \simeq 0.8$. The calculated amplitude of the ionization pulse from a single relativistic particle amounted to about 5×10^{-6} V; the experimental value was 6×10^{-6} V. (tr-auth)

12094 ETCH KINETICS OF HEAVY ION TRACKS IN SOLID STATE TRACK DETECTORS. Hasegan, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 9, 1023-9 (1972).

The variation of the track attack rate, v_T, with respect to the Restricted Energy Loss of the bombarding particle is obtained starting from the hypothesis that the track diameter is due only to the bulk rate v_B. It is concluded that the track diameter is not a parameter depending on the particle ionization. The length of the entrance cone, which is due to the unsaturated etchant, is found to depend on both the charge of the particle and the temperature of the etchant. (auth)

12095 RECENT TECHNIQUE OF LOW-LEVEL ACTIVITY COUNTING. 2. BETA-RAY DETECTION. Tanaka, Eiichi (National Inst. of Radiological Sciences, Chiba, Japan). Oyo Butsuri; 41: No. 3, 284-7(Mar 1972). (In Japanese).

GM or proportional counters are generally employed. It is important to shield the detectors with thick lead or iron to cancel out the counts due to background μ mesons in cosmic rays. To measure low energy β emitters such as ^3H and ^{14}C, the method of sealing the sample in gas state into GM or proportional counting tubes is adopted. Solid-state Detector: A Si detector with inverse coincidence counters indicates good performance; and in low level β spectrometers, in which coincidence counting is accomplished by gating GM tubes mounted in front of plastic scintillators, determination of the maximum energy of the β ray and separation of mixed nuclides have become easy. Also, liquid scintillation detectors have come to be widely used for nuclides other than ^{14}C and ^3H. (Japan)

12096 RECENT TECHNIQUE OF LOW-LEVEL ACTIVITY COUNTING. 1. ALPHA RADIOACTIVITY. Kikuchi, Jun (Waseda Univ., Tokyo). Oyo Butsuri; 41: No. 3, 281-3(Mar 1972). (In Japanese).

In parallel plate type ionization chambers, a detector of 900 cm^2 has been produced, while in the cylindrical type an area of 15,000 cm^2 has been attained. In a chamber with cylindrical grid, resolution of 45 keV for ^{210}Po α ray and background of 0.17 cph full width at half maximum have been obtained. Useable scintillators include gas scintillation, ZnS, CsI, organic crystals, and plastic scintillators. Kraner and others fabricated a 450 cc cylindrical Lucite chamber, the inside of which is coated with ZnS and which is equipped with two 5" photomultipliers, and realized the low background of 0.8 cpm. It has been found that α activity can be detected with cellulose nitrate or cellulose acetate film. Si(Li) detectors of ~20 cm^2 are being produced. (Japan)

12097 RECENT TECHNIQUE OF LOW-LEVEL ACTIVITY COUNTING. 3. GAMMA-RAY MEASUREMENT. Tanaka, Shigeo; Sakamoto, Kho (Tokyo Univ.). Oyo Butsuri; 41: No. 3, 288-9(Mar 1972). (In Japanese).

In order to gain high sensitivity in low level activity counting, it is necessary to lower the background as low as possible and to select a high efficiency detecting system. It is especially essential to make an effort to decrease the background due to the natural activity from surroundings and cosmic rays in γ ray measurement. Detectors with NaI(Tl) scintillators as the main detector are surrounded with plastic scintillators under the ground 10 to 30 m deep. Shielding and lowering of Compton counts are achieved by adopting inverse coincidence counting. Shielding for Ge(Li) requires special contrivances such as using a cooling pot of specific construction employing thermoelectric elements. (Japan)

12098 IN-CORE NEUTRON MEASUREMENTS USING SELF-POWERED NEUTRON DETECTORS. Tojo, Takao (Japan Atomic Energy Research Inst., Tokai); Kondo, Makoto; Teranishi, Kazuo. Hitachi Hyoron; 54: No. 5, 399-403(May 1972). (In Japanese).

Although fission ionization chambers are mainly employed at present for in-core neutron detectors, self-powered neutron detectors (SPD) seem to be suitable due to small size, ruggedness, and high reliability based on simple construction; and future use of these detectors is expected. SPDs having ^{103}Rh or ^{51}V as an emitter are used most generally. However, they are not suitable for neutron control that demands fast response, because their response is slow. In-core experimental results for SPDs which have ^{103}Rh or ^{59}Co as the emitter are reported. The latter can respond fast. For the SPD having ^{59}Co, the response time is practically zero, but correction is required against background

current and reverse current because of its low neutron-sensitivity. For the SPD having ^{103}Rh, the response time is 68 sec, determined from the ^{104}Rh half-life of 42 sec. However, no correction is needed for the saturation output current of the detector in neutron measurement. (Japan)

12099 ORGANIC SCINTILLATORS WITH IMPROVED TIMING CHARACTERISTICS. Birks, J. B. (Univ. of Manchester, Eng.); Pringle, R. W. Proc. Roy. Soc. Edinburgh, Sect. A; 70: 233-44 (1972).

Theoretical and experimental studies have been made of the scintillation pulse shapes of organic scintillators. In a unitary crystal the pulse shape is characterized by the scintillation decay time τ_s. In solution scintillators additional parameters are required to describe the pulse shape: Δt, the pulse width (FWHM); t_m, the time at which the intensity reaches a maximum p_{max}; and $t_{\frac{1}{2}}$, the time at which the intensity reaches $\frac{1}{2}p_{max}$. General relations are derived for τ_s, Δt, t_m, $t_{\frac{1}{2}}$, and p_{max} for binary liquid solutions in terms of molecular parameters, and the corresponding expression is given for the scintillation pulse shape of a binary plastic solution. The scintillation pulse shapes of 4 binary liquid solutions and 12 binary and 15 ternary plastic solutions were measured using a single-photon sampling fluorometer. The results confirm the theoretical analysis. A new plastic scintillator (NE 111) with improved timing characteristics has thus been developed, and some of its applications in nuclear physics are briefly discussed. The time association of nuclear events can be measured to within 130 ps with this scintillator, the limiting factor being the time jitter of the photomultiplier itself. (auth)

12100 PROPORTIONAL COUNTER AS A POSITION-SENSITIVE DEVICE. Braid, T. H. (Argonne National Lab., IL). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 9-26(1972).

The location of the trajectory of a charged nuclear particle can be determined by a number of devices whose operation depends on characteristics of gas counters operated in the region of proportional energy response. Such devices have advantages in precision, speed, and available size over other types of position-sensitive counters. The events may be located by observing pulses on one of a set of closely spaced anode wires in a common gas volume, by measuring the drift time of primary electrons to a particular anode wire, or by determining the location of an electron avalanche along the length of a single anode. The operation of the different types of systems and the factors affecting their precision are described. Precision to less than 1 mm can be obtained in a number of ways. (auth)

12101 EFFECTIVE AREA OF A COLLIMATOR FOR GAMMA RAYS FROM ^{60}Co AND ^{137}Cs. Klumpar, J.; Jirousek, P. (Lab. of Radiological Dosimetry, Prague). Czech. J. Phys.; 22: No. 12, 1328-1330(1972).

Numerical values of correction coefficients due to the penetration of gamma radiation of ^{60}Co and ^{137}Cs through the edges of a collimator are given. (auth)

12102 EFFECTIVE CENTRE OF A MODERATING SPHERE WHEN USED AS AN INSTRUMENT FOR FAST NEUTRON FLUX MEASUREMENT. Axton, E. J. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy; 26: No. 11, 581-3(Nov 1972).

A hydrogenous sphere containing a thermal neutron detector situated at the center provides a convenient system for the relative determination of fast neutron flux density. If the thermal neutron detector is a small ^{6}Li-glass scintillator or a foil it may be regarded as being situated at a point. The calibration of the system involves the determination of the scintillator counting rate (or the saturation disintegration rate of the foil) per unit flux density at the position of the centre of the sphere in the absence of the sphere. If a point source of neutrons (accelerator target or a radioactive source) is used for the calibration it can be argued that the efficiency so determined will be dependent on the source–detector distance. It is shown mathematically, however, that the efficiency is substantially independent of the source–detector distance, and it is concluded that the effective centre of the system can be regarded, for practical purposes, as being situated at the centre of the sphere. A proposal is made for a realistic expression to take account of the effectiveness of room-scattered neutrons. Reasons are given against using an extended tube BF_3 counter as the central thermal neutron detector. Some previously published experimental measurements are considered. (UK)

Radiation Dosimeters

Refer also to abstracts 12616 and 13807.

12103 (AD-743838) THIN-FOIL CALORIMETERS FOR THE MEASUREMENT OF ENERGY DEPOSITION PROFILES AND SPATIAL FLUENCE DISTRIBUTIONS OF LOW-ENERGY PULSED ELECTRON BEAMS. Graven, W. M.; Burns, W. C.; Peterson, R. V. (Aerospace Corp., El Segundo, Calif.). 23 Mar 1972. Contract F04701-71-C-0172. 37p. (SAMSO-TR-72-109). NTIS.

A thin-foil calorimeter designed to measure energy deposition profiles for electrons with ranges less than 100 micrometers has been tested with two pulsed electron beams. In addition to the diagnostic determination of the beam spectra obtained from the measured deposition profiles, the spatial fluence patterns of the beams have been measured with a total-stopping calorimeter array. The calorimeters are capable of operation over a dose range of a few kilorads to nearly 100 Mrad. Fluence measurements with the calorimeters can be made accurately with the error probably not exceeding 2 percent. In contrast, the dose-path measurements are less accurate although the probable error has not been determined. (auth)

12104 (CEA-CONF-2067) APPLICATION OF SOLID TRACK DETECTORS TO DOSIMETRY: PERSONNEL AND SPATIAL DOSIMETRY. Francois, Henry (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 8p. (In French). (CONF-720724-1). Dep. NTIS (U. S. Sales Only).

From eighth international conference on nuclear photography and solid state track detectors; Bucharest, Romania (10 Jul 1972).

Studies made on the application of solid track detectors to the dosimetry of neutrons, radon, and the concentration of α emitters in biological media are summarized. The possibilities of their use in personnel and spatial dosimetry are indicated. (J.S.R.)

12105 (DUN-SA-130) NEW RATE AND INTEGRATING PERSONAL ALARM DOSIMETER DESIGNS. Erickson, G. L. (Douglas United Nuclear, Inc., Richland, Wash.). 25 May 1970. 15p. (CONF-700609-3). Dep. NTIS.

From 15th annual meeting of the Health Physics Society; Chicago, IL (28 Jun 1970).

Pocket-sized GM dosimeters that sound an alarm when either a preset dose rate or accumulated dose is reached are described. Block diagrams for the units are shown. The pocket alarm rate dosimeter, PARD, can be set for dose rates from 20 mR/hr to 50 R/hr. The pocket alarming dosimeter integrating, PADI, has alarm points of 25 to 400 mR and a nonlatching high-dose-rate alarm set at 20 R/hr. The PADI will not fail to alarm continuously when exposed to dose rates up to and exceeding 10^6 R/hr. Results on performance testing of these two devices are included. (10 figures) (RWR)

12106 (IEA-258) THERMAL NEUTRON DOSIMETRY BY PHOSPHOR ACTIVATION. Mayhugh, M. R.; Watanabe, S.; Muccillo, R. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1971. 7p. Dep. NTIS (U. S. Sales Only).

Three common thermoluminescent phosphors, $CaSO_4$: Dy, CaF_2 : Dy, and CaF_2 : natural, were examined to determine the feasibility of their application in thermal neutron dosimetry. Basically, the phosphor was exposed to thermal neutrons (and other radiations), this exposure causing activation of nuclei in the phosphor. Next, the phosphor was stored to undergo self-irradiation from the internal radioactive nuclei, in this case, all beta emitters. Later, the thermoluminescence induced by the beta emission during storage was read. This reading depended on the original neutron exposure, and thus provided a dosimetry system. The phosphors contained suitable isotopes ^{44}Ca or ^{164}Dy (and ^{34}S). Limits for the lowest detectable fluence were determined by extrapolating results from high-fluence measurements. By using the decay of ^{165}Dy (2.3 h half-life), the lowest detectable fluence is estimated to be 5×10^7 n/cm^2. By using ^{45}Ca decay (165 d half-life), this limit is raised to about 5×10^{10} n/cm^2. Methods for improvement are discussed. (4 figures) (auth)

12107 (KFK-1666) PERSONNEL MONITORING WITH A LiF ALBEDO DOSIMETER IN THE RADIATION FIELD OF A ^{252}Cf SOURCE. Piesch, E.; Burgkhardt, B.; Vaane, J. (Kernforschungszentrum, Karlsruhe (West Germany)). Aug 1972. 40p. (In German). (EUR-4846). Dep. NTIS (U. S. Sales Only).

The use of albedo dosimeters for personnel monitoring was up to now limited to the measurement of neutrons in the intermediate and thermal energy range. Results of phantom irradiations in the radiation field of a ^{252}Cf-source however show the possibility of measuring the dose equivalent from fast neutrons. The albedo dosimeter consists of a pair of TLD 600 and TLD 700 dosimeters, from which the separate fractions of the neutron and the gamma dose can be evaluated. The TLD 600 dosimeter measures neutrons moderated and backscattered from the body as well as gamma rays. The TLD 700 dosimeter measures practically only gamma rays. The difference of the dosimeter readings (TLD 600–TLD 700) was found to be proportional to the dose equivalent of neutrons. The calibration of this albedo dosimeter was based on the results of Rem-counter measurements. Phantom irradiations were performed

in the radiation field of ^{252}Cf fission neutrons, using various source shieldings, distances to the source, and phantom sizes. The albedo dosimeter system proposed for routine personnel monitoring measures the neutron dose equivalent in the field of a ^{252}Cf-source with an overall error of ±30% which is mainly due to the influence of source shielding and backscattered radiation as well as of the variations in the angle of the radiation incidence. (auth)

12108 (PAEC(D)–723) CHARACTERISTICS OF OXALIC ACID AS A CHEMICAL DOSIMETER. Bustamante, N. T.; Abrenilla, P. (Philippine Atomic Research Center, Diliman, Quezon City). Jan 1972. 12p. INIS.

The technique is suited for dosimetry in radiation sterilization of food and medical products as well as for in-core dosimetry. The procedure is simple and the method is suitable for measuring doses in the mega-rad region. The changes in the concentration of oxalic acid when irradiated with high doses of ^{60}Co gamma-radiation were determined by titration with standard NaOH solution. The results of the study show that specific concentrations of oxalic acid should be used for a particular dose range to obtain optimum sensitivity. The irradiated oxalic acid solution was observed to be stable up to one month after irradiation. (INIS)

12109 (UCRL–74247) USE OF ^{10}B-LOADED PLASTIC IN PERSONNEL NEUTRON DOSIMETRY. Griffith, R. V. (California Univ., Livermore. Lawrence Livermore Lab.). 9 Oct 1972. 21p. (CONF-721203–6). Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

At the Lawrence Livermore Laboratory, various plastics loaded with enriched ^{10}B have been used as small shields for personnel dosimeters, in environmental neutron monitors, and for special dosimetry application. Unlike other forms of ^{10}B shielding, the borated plastic is inexpensive to fabricate, easy to handle, and can be shaped for fabricating special shields. Small discs of plastic filled with ^{10}B to a density of 1.40 g/cm^3 are now used as shields for copper and indium foils in nuclear-accident dosimeters worn by Laboratory personnel. The use of borated plastic in place of cadmium for low-energy neutron shielding increases the effective threshold for the $^{63}Cu(\eta,\gamma)^{64}Cu$ reaction by nearly two orders of magnitude. Also, by suppressing the low-energy activation, the copper response is more representative of the neutron flux for 0.1 keV to 1 MeV, which enhances the usefulness of copper as an accident dosimeter. The indium foil is covered with borated plastic to suppress the $^{115}In(\eta,\gamma)^{116m}In$ reaction. Thus, the activation of the more useful $^{115}In(\eta,\eta')^{115m}In$ threshold reaction can be almost immediately determined, without the long delay usually required for decay of the short-lived ^{116m}In activity. Also, borated plastic is being used in the development of a TLD albedo dosimeter to reduce the low-energy neutron response of the $^{6}Li(\eta,\alpha)T$ reaction in TLD-600. In addition to these applications, the $^{10}B(\eta,\alpha)^{7}Li$ reaction in the plastic has been used to locate and define low-energy neutron beams from various neutron-generating facilities. For this application, the borated material is placed against a sheet of cellulose nitrate in a neutron beam. When the cellulose nitrate is chemically etched, the pattern made by the alpha tracks accurately defines the neutron field. (auth)

12110 THERMOLUMINESCENCE DOSIMETRY WITH PHOTON COUNTING. Schlesinger, T. (Israel Atomic Energy Commission, Yavne); Avni, A.; Feige, Y.; Friedland, S. S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 34-8(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A prototype thermoluminescent dosimeter reader utilizing the photon counting technique was designed and constructed. Its capabilities, in particular the sensitivity and accuracy of the system in the low-level dose range of 1 to 1000 mR, were studied and compared with those of conventional commercial readers. An improvement by a factor of about 10 in sensitivity and a tenfold reduction of the standard deviation in the dose measurements at 25 mR was demonstrated for the photon counting technique. Refinements in the apparatus and techniques will likely improve the results further. (7 figures) (R.W.R.)

12111 BETA SPECTRUM ANALYSIS. A NEW METHOD TO ANALYZE MIXTURES OF BETA-EMITTING RADIONUCLIDES BY LIQUID SCINTILLATION TECHNIQUES. Oller, W. L.; Plato, P. (Univ. of Michigan, Ann Arbor). Int. J. Appl. Radiat. Isotop.; 23: No. 10, 481-5(Oct 1972).

A description is given of a method to couple a liquid scintillation spectrometer to a multichannel pulse-height analyzer to record beta spectra simultaneously with three different energy ranges. Spectra of tritium, ^{14}C, and ^{32}P recorded by this method are presented. Analyses of the beta spectra are performed by a least-squares technique, and the results are shown in tabular form. (auth)

12112 THERMOLUMINESCENT DOSIMETER MANUFACTURE. Johns, T. F. (to United Kingdom Atomic Energy Authority). British Patent 1,291,828. 4 Oct 1972. Filed 11 Nov 1968.

A method is described for the manufacture of pellets of thermoluminescent powder dispersed in synthetic plastic material whose translucency is resistant to heat. The materials are finely divided, intimately mixed, moulded to form a solid bar, heat treated, and slices cut from the bar of the required thickness of the pellets. The TL material may be LiF and the plastic material may be PTFE. (UK)

12113 MODIFIED SIMPLE CHLORAL HYDRATE DOSIMETER SYSTEM. Moos, W. S. (International Atomic Energy Agency, Vienna). Int. J. Appl. Radiat. Isotop.; 23: No. 11, 538-40(Nov 1972).

A chloral hydrate dosimeter system which was used as a simple go-no go indicator has been modified to indicate graduated radiation dosages. The solutions and containers used, the storage and irradiation conditions and the dose response achieved are evaluated. It is considered that the dosimeter has several attractive features such as being cheap, long storage life and ease in use. The color changes when exposed to radiation take place in the visible part of the spectrum allowing the use of less expensive spectrophotometers or possibly even a colorimeter. The possibility of using organic agents together with plastic containers allows dose measurements to be made in phantoms without interference by non-tissue equivalent material. The interaction between the solution and plastic container can be minimized by taking the reading soon after irradiation or by making appropriate corrections. Solutions kept in glass ampules for prolonged periods of time at room temperature in a dark location remained unchanged within the limits of error of the readout system. (UK)

12114 APPLICATION OF CELLULOSE NITRATE TO FAST NEUTRON DOSIMETRY. Dragu, A.; Nicolae, M. (Institutul de Fizica Atomica, Bucharest). Radioprotection; 7: No. 2, 87-102(1972). (In French).

Solid state track detectors have some advantages over nuclear emulsions in fast neutron dosimetry. The two main processes used to detect the neutrons are examined: the elastic scattering of neutrons by carbon, nitrogen and oxygen nuclei with the detection of the recoil nuclei (the theoretical yield of a Pu–Be source is 10^{-5} tracks per neutron); and interactions involving (n,α) reactions with these elements (with the same spectrum, the corresponding yields is 8.10^{-6} tracks per neutron). The good agreement between the experimental results and the theoretical calculations concerning cellulose nitrate detectors indicates their suitability as fast neutron integrating devices for energies below 10 MeV with conventional neutron sources having known spectra. (auth)

12115 EUROPIUM-ACTIVATED SINGLE CRYSTALS OF KCl USED IN RADIOTHERMOLUMINESCENT DOSIMETRY. Avdonin, V. P.; Begak, O. Yu.; Vasil'ev, I. A.; (and others). At. Energ. (USSR); 33: No. 5, 929-30(Nov 1972). (In Russian).

The thermoluminescence of KCl : Eu crystals when irradiated in the usual manner (e.g., at 20°C with β-particles from a $^{90}Sr/^{90}Y$ source) was characterized by two peaks at ~100° and 190°C. The size and ratio of these two thermopeaks depended on the dose and dose rate of the ionizing radiation. The sensitivity of a dosimeter based on the KCl : Eu crystals was 0.8 erg/cm^2 for α-particles, and 5 μR for γ-radiation. (K.S.W.)

12116 BELT FOR RADIATION DOSIMETRY. Tonnelier, C.; Zerbib, J.-C. (to Commissariat a l'Energie Atomique). French Patent 2,108,861. 26 May 1972. Filed 13 Oct 1970. (In French).

A special belt for personnel radiation dosimetry is presented. This belt enables the angle from which the incident radiation originates to be determined. The parts of the body irradiated can subsequently be defined. The belt which is constructed of an elastic material, is provided with a number of pockets, each pocket containing a sulfur based detecting element. Each detecting element is provided with at least one ebonite pellet. (France)

12117 UTILIZATION OF CARBON TETRACHLORIDE SOLUTION IN ALCOHOL(C_2H_5OH) FOR DETERMINATION OF ABSORBED DOSES. Vakhlakova, T. V.; Skoropad, Yu. D. (Scientific-Research Inst. of Medical Radiology, Moscow). Med. Radiol.; 17: No. 9, 67-70(Sep 1972). (In Russian).

The investigations carried out have confirmed a relatively high sensitivity to the ionizing radiation of the dosimeter composed of a 94% (by weight) mixture of CCl_4 and 6% (by weight) of alcohol. It was established that dosimeter indications are independent of the dose rate within the range of 0.6 to $5.1.10^2$ rads/min of the surrounding medium temperature under irradiation within the range of 15 to 30°C and that there are linear indications from the dose of 1 to 50 rads. Due to the physical characteristics the system may be considered to be bone equivalent and can be utilized for registering absorbed doses in bones under roentgenological

procedures. The indicated shortcomings of the system are dependence of the storage terms on temperature, the effect of light and admixtures, and the necessity of manyfold exposure of the model. (auth)

12118 IMPROVED METHODS FOR MEASUREMENTS OF THERMAL NEUTRON DOSE BY THE FISSION-TRACK TECHNIQUE. Seitz, M. G. (Carnegie Inst. of Washington, DC); Walker, R. M.; Carpenter, B. S. J. Appl. Phys.; 44: No. 1, 510-12(Jan 1973).

Scanning electron microscope and reflected light observations of fission tracks are described that lead to highly reproducible track density measurements for different observers. These new observational techniques are used to calibrate two uranium-doped glasses for neutron dose measurements. The glasses are available to other investigators. (auth)

12119 IMPROVEMENTS IN OR RELATING TO IONISATION DOSIMETERS. Cooper, P. N.; Tymons, B. J. (to R. A. Stephen and Co. Ltd.). British Patent 1,290,493. 27 Sep 1972. Filed 2 Dec 1969.

Neutron radiation is always accompanied by some γ-radiation, and it is difficult to discriminate between the two forms of radiation dosimetrically or to measure the effective biological dose in a mixed radiation field. Hitherto two dosimeters have been used, the first being sensitive to both neutron and γ-radiation, and the second mainly sensitive to γ-radiation. This involves bulky apparatus and is liable to error in use. The dosimetric system described provides at least partial compensation for γ dosage. Two ionization chambers are provided, with substantially different ratios of neutron to γ response. One pair of electrodes of the two chambers is connected together and the other pair is coupled through a capacitance. The two chambers are arranged to be electrically charged with opposite polarities and then isolated from the charging means during measurements; the potential across the capacitance is then proportional to the difference between the responses of the two chambers to the received radiation. Means are provided within one chamber for indicating the magnitude of the voltage charge between the electrodes of the chambers that have the greater neutron to γ response. This voltage charge is proportional to the effective biological dose received by the dosimeter. (UK)

12120 $BaTiO_3$: CERAMIC AS NEW EXOELECTRON EMITTER Lausch, W.; El Naggar, S. (Technische Univ., Dresden). Radiochem. Radioanal. Lett.; 12: No. 2-3, 177-84(29 Nov 1972). (In German).

$BaTiO_3$-ceramic is proposed as a new TSEE-dosimeter for low doses. The preparation of the dosimeter is described and its most important properties are investigated. (auth)

12121 RADIATION DOSIMETRY BY A NEW SOLID-STATE EFFECT. Podgorsak, E. B.; Moran, P. R. (Univ. of Wisconsin, Madison). Science; 179: No. 4071, 380-2(26 Jan 1973).

Ionizing radiation can induce strong electrical polarization phenomena in dielectric solids. These radiation-induced thermally activated depolarization (RITAD) effects are quite different from radioelectret effects. For nominally pure calcium fluoride samples, the RITAD signals show a signal-to-noise power advantage of 40 decibels over that of thermoluminescence signals measured under the same experimental conditions. Ease of measurement, very high radiation sensitivity, and simple sample fabrication requirements give the RITAD phenomena a great potential for use as a new solid-state dosimetry technique. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 11705 and 12193.

12122 (AD-747590) NRL OSO-4 BRAGG CRYSTAL SPECTROMETER INSTRUMENT. Meekins, J. F. (Naval Research Lab., Washington, D. C.). 27 Jul 1972. 23p. (NRL-7423). NTIS.

Two Bragg crystal spectrometers were placed on the OSOg4 satellite to study solar flare plasmas by their spectral emissions. The solar flare plasma parameters were measured with these spectrometers, which together covered a total wavelength range of 0.6 to 8.4A. With these instruments, knowledge could be gained into the mechanisms governing the plasma behavior in the high temperature-low density regime of flare production and in solar evolution and elemental abundances in the sun. However, spacecraft limitations forced many restrictions on the design of the instrument, so the final instrument could not measure all the solar flare plasma state parameters. (auth)

12123 (INR-P-1423) ANOMALOUS REFLECTION IN NEUTRON TRIPLE AXIS CRYSTAL SPECTROMETER. Maliszewski, E.; Sosnowski, J.; Bednarski, S. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 10p. Dep. NTIS (U. S. Sales Only).

The origin of the anomalous peaks occurring in neutron crystal spectrometers is explained by using the reciprocal space geometry. (auth)

12124 (JINR-P10-6655) KATOK-B PROGRAM. Gadzhokov, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The changes are described introduced into the KATOK program for processing spectra from Ge(Li) detectors on Minsk-2 (-22) computers. The new program version runs four times faster than the previous one, conserving the same precision. For the sake of comparison, the results of a numerical experiment are given in which sample spectra were processed with both the old and the new versions of the program discussed. (auth)

12125 (LA-DC-72-1441) EXPERIENCES IN LEAST SQUARES OPTIMIZATION IN THE LASL ENVIRONMENT. Klein, M. M. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 23p. (CONF-720727-1). Dep. NTIS.

From Regional seminar on the numerical solution of nonlinear algebraic systems; Pittsburgh, PA. (Jul 1972).

A modified Levenberg algorithm for nonlinear least squares minimization which has been used in the design of optical lens systems and charged particle high resolution spectrometers is described. (W.H.K.)

12126 AUTOMATIC X-RAY DIFFRACTION SPECTROGRAPH. Kinsey, J. H.; Reynolds, G. T. (Princeton Univ., NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 214-18(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Rapid advances in molecular biology have indicated the desirability of using the image intensification technique instead of photographic film. The availability of video processing systems makes it feasible and desirable to automate the design of such a system, and digital controls were developed. The components, calibration, and operation of an automatic x-ray diffraction spectrograph are described, including the x-ray generator, scintillator, image intensifier tube, computer, and computer interface (containing the video processing circuitry). (6 figures) (R.W.R.)

12127 MERCURIC IODIDE GAMMA-RAY SPECTROMETER. Malm, H. L. (Chalk River Nuclear Labs., Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 263-5(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Crystals of HgI_2 (E_g = 2.1 eV) were operated as conduction-type γ-ray spectrometers at room temperature. Two-carrier collection was observed, and collection of the electrons was sufficiently good to give full-energy peaks for γ rays of energies below 100 keV. A resolution of 10 keV fwhm was observed for the 18-keV x-ray from ^{241}Am. Room temperature spectroscopy in the energy region <100 keV is possible due to the high stopping power of HgI_2 (Z = 80, 53) and the low dark conductivity ($\sim 10^{-13}$ $(\Omega.cm)^{-1}$). With the present material the mobility-life-time product is 10^{-5} to 10^{-4} cm^2/V for electrons and is 10^{-6} to 10^{-5} cm^2/V for holes. (3 figures, 2 tables) (auth)

12128 GROOVE DETECTORS FROM HIGH-PURITY GERMANIUM. Baertsch, R. D. (General Electric Corporate Research and Development, Schenectady, NY). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 275-80(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Detectors were fabricated from pure germanium with a lithium-diffused N+ contact and a P+ contact which is ion implanted in a dc glow discharge in boron trifluoride. A deep groove is used to increase the breakdown voltage. Measurements of the current-voltage characteristics of these detectors after temperature cycling are reported. The correlation of smooth etch pits with severe trapping in pure germanium detectors is shown. Finally, the performance of a few large detectors is given. (8 figures, 1 table) (auth)

12129 INTERFACE EFFECTS ON THE SPECTRAL RESPONSE OF LIQUID PHASE EPITAXIAL n-GaAs RADIATION DETECTORS. Tavendale, A. J.; Lawson, E. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 318-23(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Two undesirable features exhibited by gold surface-barrier detectors from liquid-phase epitaxial (LPE) n-GaAs are the variation in pulse height response with bias and multipeaking effects

near full depletion. Capacitative attenuation by the high-resistivity epitaxy–substrate interface (ESI) layer is considered to be the origin of these effects. Such anomalous interface layers are well known in the application of LPE GaAs to Gunn oscillator devices, and a review of their properties is presented. The response of detectors at room temperature when subjected to IR illumination was markedly improved in the multipeaking region, and slow components in the pulse rise time were removed. The presence of a deep level acceptor in the ESI layer 0.31 to 0.76 eV from the valence band is inferred. Other methods for the reduction of ESI effects are discussed. (9 figures) (auth)

12130 PERFORMANCE OF GaAs SURFACE-BARRIER DETECTORS MADE FROM HIGH-PURITY GALLIUM ARSENIDE. Kobayashi, Tetsuji; Sugita, Tohru; Koyama, Masaki; Takayanagi, S. I. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 324-33(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Gallium arsenide surface-barrier diodes were fabricated from high-purity materials. These devices had a Au surface barrier having a depletion layer thickness of from 70 μm to 1 mm and an area of from 3 mm^2 to 27 mm^2. These devices were operated as α-particle, β-ray, and γ-ray spectrometers and detectors. The best energy resolutions taken with a GaAs detector made from liquid-phase epitaxial GaAs wafer were 20 keV (fwhm) and 8 keV for 5.486 MeV α particles from ^{241}Am and 115 keV conversion electrons from ^{57}Co at room temperature, respectively. For room-temperature applications, a simple charge-sensitive preamplifier was constructed using two FET's and one OP amp. The combination of an encapsulated GaAs detector and two small semiconductor thermoelements (electrical cooling device) was studied to make a simple x- or γ-ray spectrometer. A special tiny GaAs detector was also fabricated as a β-ray counting detector for biomedical applications in vivo. The energy per electron–hole pair (ϵ) in GaAs was measured as 4.35 + 0.02 eV for α particles with a linear variation with bandgap energy (Eg) of 2.53 over a temperature range of 195°K to 330°K, and 4.57 eV for conversion electrons (115 keV) at 300°K, respectively. The ϵ vs. Eg relationship was also investigated for Ge, Si, GaAs, and CdTe by using experimental values, and led to $\epsilon = 2.59_8\ Eg + 0.71_4$ (eV) with correlation coefficient of 0.999 at 300°K. The related problems for intrinsic material constant (ϵ) are discussed for several semiconductor materials. (18 figures, 2 tables) (auth)

12131 RECENT ADVANCES IN THE PREPARATION OF CdTe FOR NUCLEAR DETECTORS. Bell, R. O.; Wald, F. V. (Tyco Labs., Inc., Waltham, MA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 334-8(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The traveling-heater method (THM) of growing CdTe with a tellurium solvent was used to produce single crystals with low carrier concentrations from which gamma-ray detectors were fabricated. The use of Cl, Br, or I as compensating dopants in the CdTe resulted in material with improved $\mu\tau$ products $[(\mu\tau)_n \approx 4 \times 10^{-4}$ cm^2/V and $(\mu\tau)_p \approx 8 \times 10^{-5}$ cm^2/V]. The dopant was added to the tellurium solvent as the cadmium salt in concentrations of 100 to 500 ppm by weight of the solvent. The best results to date were obtained with Cl. An analysis of the temperature distribution during THM shows that it is possible to obtain a flat isotherm, which is necessary to propagate single crystals. Low-speed rotation (1 to 5 rpm) promotes a more symmetrical thermal distribution and improves the crystallinity of the CdTe. (7 figures) (auth)

12132 HIGH PURITY N-TYPE GALLIUM ARSENIDE FOR NUCLEAR PARTICLE DETECTION. Gibbons, P. E.; Howes, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 353-7(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Room-temperature-operating x- and alpha-ray spectrometers were made with gallium arsenide. Surface-barrier diodes using gold or palladium were fabricated on high-purity material grown by liquid-phase epitaxy. The epitaxial layers had a thickness varying from 30 to 120 μm and an electrically active impurity concentration varying from 5×10^{12} to 1×10^{14} per cc. These layers deplete with only 8 volts reverse bias. Diodes of 4 to 8 mm^2 area gave a resolution of 15.5 keV fwhm for 5.48-MeV alpha particles at room temperature, and 40 keV, at 120°C. Similar devices gave a resolution of better than 5 keV fwhm for 60-keV x-rays at 25°C. The bulk-generated currents were as low as 2.5 nanoamperes per cubic millimeter. (6 figures, 2 tables) (auth)

12133 ION IMPLANTED CONTACTS ON CADMIUM TELLURIDE DETECTORS. Cornet, A.; Hage-Ali, M.; Grob, J. J.; Stuck, R.; Siffert, P. (CRN, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 358-61(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Cadmium telluride single crystals were grown by the vertical zone melting technique. Without added chemical impurities, they are generally n-type of 10 to 100 Ω-cm resistivity. Detectors were prepared with this material by implanting Bi^+ ions. The influence of the implant conditions and annealing treatments were studied. A fwhm of 24 keV was obtained at 300° and 77°K for 5.5-MeV α particles. (auth)

12134 FINAL RESULTS ON THE NATURE OF THE PULSE-HEIGHT SPECTRUM FROM SEMICONDUCTOR DETECTORS. Strokan, N. B.; Eryomin, V. K.; Lomashevich, S. A.; Tisnek, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 365-79(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

An analysis of the shape of the pulse height spectrum is carried out. The sequence of the physical processes which participate in shaping signals in a detector is taken into consideration. Attention is primarily directed to the charge collection process and to the spread in the amplitude $C_0(q)$ due to incomplete collection. A generalized analytical expression is obtained for the quantity q and the function $C_0(q)$ for detectors of the most widely used configurations (planar, coaxial, spherical). An analysis is given of the difference in two conventional approaches to the problem of calculating the total pulse height spectrum shape. It is noted that under ordinary conditions of gamma spectrometry the spectrum undergoes essential symmetrization due to multiple scattering (Compton scattering with subsequent photoabsorption). This brings the results of calculations closer to one another. However, in a single-step interaction (resulting, for instance, in the double-escape peak) simple summation of dispersions for the spectrum components would lead to considerable errors. A scheme is outlined to permit using a pulse height analyzer in calculations of the spectrum shape. The results of an experiment are presented which show that the signal across the detector electrodes is connected with potential differences traversed: $\Delta q \sim \Delta v/v$. This relationship was used to calculate the charge q and the spectrum $C_0(q)$. (14 figures, 1 table, 29 references) (auth)

12135 HIGH RATE X-RAY FLUORESCENCE ANALYSIS BY PULSED EXCITATION. Jaklevic, J. M.; Goulding, F. S.; Landis, D. A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 392-5(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The application of pulsed x-ray excitation to x-ray fluorescence spectrometry is described as a method for increasing the output counting rate of the system by a substantial factor. By using a pulsed x-ray tube that is immediately turned off when a signal is detected and held off during the pulse processing time, it is possible to eliminate the need for a pulse pile-up rejection. Output counting rates significantly greater than with conventional operation for equivalent shaping networks were achieved. No significant degradation in spectrometer resolution was observed at the increased counting rates. (16 figures) (auth)

12136 TIMING SYSTEM FOR Ge(Li)-DETECTORS. Akimov, Yu. K.; Andert, K.; Kalinin, A. I.; Ortlepp, H. G. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 404-10(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A timing system for coincidence and nuclear-lifetime measurements with Ge(Li) detectors is described. The timing discriminator, based on the ARC (amplitude and rise time compensation) principle, is designed using integrated circuits. Uncompensated pulses from low-energy events near the threshold of the timing discriminator are eliminated by a special internal coincidence circuit. Output pulses caused by noise are excluded by duration discrimination. The detector signals are amplified by a preamplifier and a fast amplifier with 2.5 and 3.5 ns risetimes, respectively. Time resolutions of 15.6, 2.7, and 1.1 ns fwhm were obtained for energies of 50, 511, and 1330 keV, respectively, by using a planar detector (1.9 cm^3) with a charge collection time of 40 ns. The differential peak shift in a range from 10 to 1330 keV was 1.2 ns. (auth)

12137 SCATTER SPECTROSCOPY. Els, R. A.; Schneider, R. H.; Nyberg, P. C.; Ohlhaber, T. R.; Rose, H. A. (Bureau of Radiological Health, Rockville, MD). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 411-17(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

In high-flux-density ionizing photon fields it is usually difficult to measure photon spectra with Ge(Li) or Si(Li) semiconductor radiation detectors. A method, which is an extension of that reported by Unsworth and Greening, was developed to sample scattered photons from a photon beam. A thin sheet of low-atomic number material is placed in the photon beam, and is observed by a collimated detector from some convenient angle, θ, away from the beam direction. Only a small fraction of the photons are scattered into the solid angle of the detector. An approximation of the energy spectrum of the primary beam may be obtained by calculating the primary photon energies from the measured scattered photon energy spectrum. This method differs from that of Unsworth and Greening by considering Compton and Rayleigh scattering separately. (16 figures) (auth)

12138 SIGNAL PROCESSING SYSTEM FOR A SEMICONDUCTOR DETECTOR LADDER. Whittaker, J. K. (National Bureau of Standards, Washington, DC). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 444-52(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The resolution of the NBS high-resolution electron spectrometer was improved by installing a new 48-channel detector array at its focal plane, in place of the original channel array that had been in use for some time. This necessitated the design and construction of a new electronics system to accommodate the increased amount of information from the detectors. The new detector system digitally processes the signals from the detectors after amplification and discrimination. It is coupled on line to a computer, which accumulates and manipulates the processed data. An effective and economical solution was found for the construction of a large logic network for nuclear data accumulation. The functions provided are those normally found only in modular form, e.g., coincidence, with the necessary time resolution. Time differences for simultaneous signal paths were restricted to ±1 ns maximum with a minimum pulse width of 5 ns for any pulse input. The entire system is dc coupled; and the pulse pair resolution, measured during construction, is 10 ns. (10 figures) (auth)

12139 RESPONSE OF A SILICON SURFACE-BARRIER DETECTOR TO BROMINE, IODINE, AND URANIUM IONS. Brown, M. D. (Oak Ridge National Lab., TN). Nucl. Instrum. Methods; 106: No. 1, 141-5(1973).

Multicomponent bromine, iodine, and uranium beams from the Oak Ridge Tandem accelerator were used to measure the pulse height response of silicon surface-barrier detectors in the ion energy range 20 MeV to 100 MeV. The detectors were found to have pulse height defects of 3.0 ± 0.5 MeV, 4.0 ± 0.5 MeV, and 6.3 ± 1.0 MeV corresponding to bromine, iodine, and uranium ions, respectively. An energy-dependent correction larger than the pulse height defect is needed for iodine and uranium response data over most of the energy range studied. Certain previously published theoretical explanations which attribute detector nonlinearities to atomic scattering at the end of the ion range are in reasonable agreement with these results. (4 figures) (auth)

12140 TIME-OF-FLIGHT SPECTROMETER FOR NEUTRONS FROM 1 TO 500 MeV. Madey, Richard; Waterman, F. M. (Kent State Univ., OH). Nucl. Instrum. Methods; 106: No. 1, 89-101 (1973).

A self-contained time-of-flight spectrometer was developed for neutrons from 1 to about 500 MeV. The spectrometer consists basically of two scintillation counters. The principle of the spectrometer requires an incident neutron to scatter elastically from a proton in the first scintillator, travel over a known flight path, and interact in the second scintillator. The time interval between the scintillation pulses in the two detectors is the time of flight of the scattered neutron. Kinematically, the kinetic energy of the incident neutron is specified in terms of the scattering angle, the flight path, and the flight time of the scattered neutron. The intrinsic time dispersion of the system is 2.2 ns (fwhm) with a 2½'' dia by 2½'' high first scintillator and a 9'' dia by 8'' thick second scintillator. For a mean flight path of 4 m between these two scintillators, the energy resolution of the spectrometer varies from about 7 to 20%, and the spectrometer efficiency varies from about 2×10^{-5} to 8×10^{-7} over the range of energies from 10 to 500 MeV. The background from interactions of neutrons above about 15 MeV with carbon nuclei in the first scintillator is subtracted by measuring the spectrum twice, with first scintillators differing significantly in their relative hydrogen–carbon composition. Measurements with monoenergetic neutrons at 14 MeV confirm the resolution and efficiency of the spectrometer at low energies. Measurements with monoenergetic neutrons at 220 MeV verify the resolution of the spectrometer at this energy and demonstrate the technique for subtracting the carbon background. Neutron spectra from 740-MeV proton bombardment of a 30-cm thick uranium target were measured over the energy range from 1 to 500 MeV. In each of these measurements, the count rate of real events was typically a count/s, and the chance coincidence count rate was of the same order of magnitude. (10 figures). (auth)

12141 REDUCTION OF COSMIC-RAY INDUCED BACKGROUND IN PROPORTIONAL COUNTER ROCKET EXPERIMENTS. Cooke, B. A.; Griffiths, R. E.; Janes, A. F. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods; 106: No. 1, 147-55(1973).

The reduction of cosmic-ray-induced background events in proportional counter rocket experiments is discussed for the energy range 1 to 20 keV. The results from two Skylark rocket flights are presented, one employing scintillator anticoincidence and the other proportional guard anticoincidence, both using rise time discrimination. The results are analyzed in terms of the interactions which produce the background. (3 figures, 3 tables) (auth)

12142 SIMPLE MOESSBAUER RESONANCE COUNTER FOR SURFACE STUDIES. Fenger, J. (Danish Atomic Energy Commission Research Establishment, Risoe). Nucl. Instrum. Methods; 106: No. 1, 203-4(1973).

A previously described resonance counter can be used for Moessbauer studies of surfaces of flat samples of almost any size and thickness. (3 figures) (auth)

12143 HIGH RESOLUTION, HIGH SENSITIVITY COMPTON POLARIMETER. Canty, M. J.; Neskakis, A. (Univ., Bonn). Nucl. Instrum. Methods; 106: No. 1, 1-7(1973).

A solid-state Compton-effect polarimeter consisting of three coaxial Ge(Li) detectors was constructed for use in measuring gamma-ray linear-polarization angular correlations. The polarimeter was calibrated for polarization sensitivity by using sources of known linear polarization, the result being in reasonable agreement with a Monte Carlo calculation of the sensitivity. Comparison is made with similar devices in the literature. (5 figures, 2 tables) (auth)

12144 METHOD OF MEASURING THE SPECTRA OF PARTICLES IN IRRADIATED MEDIA. Hyver, C. (CEN de Saclay, Gif-sur-Yvette, France). Radioprotection; 7: No. 2, 63-76 (1972). (In French).

The measurement of the energy and angular distribution of γ ray photons in irradiated media is discussed. A method is suggested in which the photons are directed from the media to a spectrometer by a hollow plastic guide. Energy spectra in the 50 keV to 1.5 MeV range can be studied. The geometry of the experimental set up, the calibration of the detector spectrometer, and the method used to obtain information from the spectra are discussed. (France)

12145 COMPTON SPECTROMETER HAVING PRIMARY AND SECONDARY DETECTORS WITH LOW AND HIGH ATOMIC NUMBERS, RESPECTIVELY. Hick, H. P.; Pepelnik, R. (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). U. S. Patent 3,699,340. 17 Oct 1972. Priority date 31 Oct 1968, Austria.

A Compton spectrometer having semiconductors which intercept the primary and secondary or back scattered radiation is described. One of the detectors is made of a material having a low atomic number and the other detector is made of a material of high atomic number. (auth)

12146 SIMPLE DETECTION SYSTEM FOR (H.I.,α) REACTIONS. Rosner, B.; Tserruya, I. (Technion-Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods; 105: No. 3, 585-7(1972).

A simple, inexpensive detection and identification system for alpha particles emitted from (HI,α) reactions is described. The system employs only sum analysis from a $\Delta E-E$ detector telescope and a one-dimensional multichannel analyzer. (auth)

12147 GAMMA SPECTROMETER FOR SEA- OR LAKE-BOTTOM SURVEYING. Bowie, S. H. U.; Clayton, C. G. (Inst. of Geological Sciences, London). Inst. Mining Met., Trans./Sect. B; 81: 215-16(Nov 1972).

A description is given of a gamma spectrometer intended for use in surveying for radioactive rocks under water. The instrument is towed in contact with the sea or lake bottom. It comprises a stainless steel cylinder containing a NaI(Tl) detector and high voltage supply unit, fixed at the end of a reinforced rubber hose of the same diameter as the cylinder. The towing cable is of coaxial double-armoured type. A weak link and a marker buoy are incorporated in the system so that, in case of snagging on the sea-bottom, the probe could be recovered. The spectrometer is based on the Harwell 2000 series and is designed to measure total-gamma count as well as count rates in three channels, the energy limits of which are within 1.3 to 1.6 MeV (potassium), 1.66 to 1.86 MeV (uranium) and 2.3 to 3.3 MeV (thorium). Output can be recorded in analogue and digital form. The performance

of the instrument, and geographical areas of useful application, are discussed. (UK)

12148 REDUCTION OF THE OVERLOAD SENSITIVITY OF A Ge(Li) SPECTROMETER SYSTEM. Huber, K.; Bartsch, H. (Univ., Giessen, Ger.). Nucl. Instrum. Methods; 105: No. 3, 589-92(1972). (In German).

This paper presents a facility to reduce the dead time of a Ge(Li) spectrometer system to less than 5 μs after having been overloaded by a radiation burst. A gate circuit for a charge sensitive preamplifier, which allows compensation of overload of the detector up to 100 nA, is described. The increase of noise due to this circuit was measured to 0.13 keV. This corresponds to an increase of the input capacitance of about 6 pF. The recovery time of the preamplifier is less than 1 μs. To prevent blocking of the following RC-shaping main amplifier caused by the remaining pedestal of the gated preamplifier, an additional device was developed which allows a temporary shortening of the time constant of the first differentiation of the main amplifier. This provides a fast return to the base line after an undesired pulse from the preamplifier. This modified amplifier system needs less recovery time (1 to 2 μs) after a radiation burst than the Ge(Li) detector itself. (6 figures) (auth)

12149 THRESHOLD DETECTOR MEASUREMENTS WITH SEALED TUBE DT NEUTRON GENERATORS. Lawson, R. C.; Porter, D.; Hannan, W. J. (Western Regional Hospital Board, Glasgow). Phys. Med. Biol.; 17: No. 6, 771-82(Nov 1972).

As part of a fast neutron therapy project, neutron fields from DT generators have been investigated using reactions in ten threshold detectors: ^{58}Ni(n,2n), ^{19}F(n,2n), ^{63}Cu(n,2n), ^{27}Al(n,α), ^{56}Fe(n,p), ^{27}Al(n,p), ^{58}Ni(n,p), ^{232}Th(n,f), ^{238}U(n,f) and ^{237}Np(n,f). Irradiation and counting experiments were made in good geometry to confirm the activation parameters. Spectra deduced from threshold detector measurements in simulated therapy conditions were compared with those obtained using a proton recoil spectrometer. (auth)

12150 LIQUID SCINTILLATION SPECTROMETER. Rosenstingl, E. (to Intertechnique SA). French Patent 2,110,761. 2 Jun 1972. Filed 29 Oct 1970. (In French).

A liquid scintillation spectrometer for measuring the real activity of a radioisotope or radioisotopes in samples is presented. A batch of N samples having known activities is examined and counting rates (E) corresponding to a radioisotope or radioisotopes are determined together with the value of r (quenching correlation parameter). After this calibration procedure, the values of r are determined for the samples under investigation. The corresponding values of E are deduced for the radioisotope or radioisotopes of the samples under investigation, the net count rate being corrected using the value of E determined. The correlation parameter r is the amplitude corresponding to the centroid of the amplitude spectra system of the light pulses produced by the radioisotope, the most energetic radioisotope of the sample, or the fraction of the spectra contained in a predetermined amplitude band. (France)

12151 ELECTROSTATIC DEFLECTION VS.ENERGY INSTRUMENT FOR MEASURING INTERPLANETARY PARTICLES IN THE RANGE 0.1 TO ~3 MeV/CHARGE. Fan, C. Y. (Univ. of Arizona, Tucson); Gloeckler, G.; Tums, E. pp 1602-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 4).

An instrument suitable for measuring the differential energy spectra and charge composition of interplanetary charged particles between 100 keV and 2.4 MeV/charge is described. The charge state and energy are determined by a simultaneous measurement of the total particle energy and the amount of deflection in an electrostatic field. In addition to detecting nuclei or ions with charges between 1 and 26, electrons and positrons up to 4.2 MeV are separately identified. Calibrations using Van de Graaff protons, α-particles and heavy ions show that the instrument will identify protons, α-particles, L(Li Be B), M(CNO) and iron group nuclei. (auth)

12152 CROSSED-COIL NUCLEAR MAGNETIC RESONANCE PROBE FOR HIGH SENSITIVITY LOW TEMPERATURE MEASUREMENTS. Drain, L. E. (Argonne National Lab., Ill.). Rev. Sci. Instrum.; 43: No. 11, 1648-50(Nov 1972).

A crossed-coil probe suitable for nuclear magnetic measurements at low temperatures is described. The probe may be used with commercial continuous wave spectrometers and enables improved sensitivity to be obtained, particularly at liquid helium temperatures. The electrical balance of the probe is controlled by an external circuit, and because the probe is compact and contains no moving parts, it may be cooled conveniently. Thermal insulation of the sample from the probe is, therefore, unnecessary and high filling factors may be obtained. High performance Dewar vessels may be used giving economy of refrigerant, freedom from microphonic interference, and the possibility of long uninterrupted runs at liquid helium temperatures. Factors that influence the design and performance of probes of this type are discussed. (auth)

12153 APPLICATION OF THE MULTICHANNEL ANALYZER Al-256 TO β- AND MASS SPECTROSCOPY. Voronin, A. M. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 57-60(1972). (In Russian).

Apparatus for recording β- and mass spectra is described which is based on a modulated magnetic field in the spectrometers and synchronized with the AI-256 multichannel analyzer. The analyzer was adjusted for operation for slow time analysis. Application of this method is suitable for the construction of equipment for fast analysis and in the investigation of short-lived isotopes. (tr-auth)

12154 NEW METHODS FOR OBSERVING MOESSBAUER SPECTRA. Voronin, A. M. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 61-4(1972). (In Russian).

Equipment was designed for observing the differential pattern of Moessbauer spectra, to be used in conjunction with an AI-256 multichannel analyzer. The circuitry included an electrodynamic vibrator, a gamma source, an absorber, detector, power amplifier, and a single vibrator. Its operational characteristics are discussed. (KSW)

High Energy Physics Instrumentation

Refer also to abstracts 12229, 13015, 13024, and 13085.

12155 RECENT ADVANCES IN HIGH-ENERGY PARTICLE DETECTORS. Roberts, Arthur (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 122-5(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Some developments in the field of detectors and detector instrumentation as applied to high-energy particle physics are briefly reviewed. For some time electron and gamma shower detectors with 100% efficiency and increasingly good energy discrimination have been available; present emphasis is on spatial discrimination obtained by using sampling procedures with scintillation counters or proportional counter planes. The momentum and energy of hadrons can also be determined by total-absorption methods. Performance of Cherenkov counters has improved so that it is now limited by dispersion; hence, new developments tend toward smaller cone angles, giving less light but better resolution. They can be used to identify beam components at energies of 400 GeV or more. A new kind of image-dissecting Cherenkov detector, based on the availability of a highly collimated parallel beam in which the momentum of the particle is a function of only its direction, is under development for distinguishing the various charged hyperons from antiprotons and other negative particles in a 150-GeV/c negative hyperon beam. Two new sorts of detectors that attempt to distinguish among relativistic particles by observing the relativistic rise are under development. One consists of a series of proportional counters that samples the ionization of each particle at many points along its path in a suitable gas; the other is a detector of transition radiation. Wire spark chambers can now provide spatial resolution of 60 to 100 microns. Significant advances in resolution have also been reported for liquid xenon detectors. (5 figures) (R.W.R.)

12156 PROPERTIES AND APPLICATIONS OF LARGE NaI(Tl) TOTAL ABSORPTION SPECTROMETERS. Hughes, E. B.; Ford, R. L.; Hofstadter, R.; (and others) (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 126-33(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The properties of large NaI(Tl) crystal assemblies, 16 and 30 in. in diameter, as total-absorption spectrometers for electrons and photons are reported. Measurements of the response of such large crystals are reviewed and interpreted. With properly constructed assemblies, the resolution is limited by leakage fluctuations. Applications of large NaI(Tl) or CsI(Tl) assemblies are also discussed. They have been used to measure secondary gamma yields induced by bremsstrahlung beams on various targets in the range hydrogen to lead at the Stanford Mark III Linear Accelerator. The principal aim of the experiment was to measure the difference spectrum between the two end-point energies that lie immediately above and below the first pion–nucleon resonance. A telescope, to be launched aboard the second High Energy Astronomy Observatory, is being developed to detect and measure high-energy gamma rays in space. In this connection studies were made of the possibility that the backscattered radiation emerging from the front

face of the crystal might deposit enough energy in the anticoincidence shield to veto an otherwise acceptable gamma-ray event. It was concluded that backscatter will not severely affect the major part of the data from this experiment. A third application of large crystal spectrometers is to the measurement of the inclusive π^0 production cross section in the reactions $\pi^{\pm} + p \rightarrow \pi^0 +$ anything at energies of 10 to 16 GeV. A final application is to the detection of photons produced in electron–positron interactions at cms energies in the range 2 to 5 GeV at SPEAR. In particular, the annihilation reaction $e^+ + e^- \rightarrow 2\gamma$ and the "Compton" interaction $e^+ + e^- \rightarrow e^+ + e^- + \gamma$ will be studied. (15 figures, 1 table) (R.W.R.)

12157 PERFORMANCE OF A THALLIUM CHLORIDE SCINTILLATOR AS A TOTAL ABSORPTION SHOWER CASCADE DETECTOR. Schilling, R. F. (Stanford Univ., CA); Crawford, J. F.; Ford, R. L.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 134-6(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Studies were made of the performance of a large sample of the new heavy scintillator TlCl(Be,I) as a total absorption shower cascade (TASC) detector for high-energy electrons and gamma rays. The observed energy resolution for electrons in the range 0.1 to 15 GeV is reported and compared to a Monte Carlo calculation of expected fluctuations in energy leakage from the crystal volume. The performance of this new scintillator and its potential applications are discussed. (2 figures) (auth)

12158 RESPONSE OF TlCl (I,Be) CRYSTALS TO ENERGETIC IONIZING RADIATION. Farukhi, M. I. (Harshaw Chemical Co., Solon, OH); Crannell, Hall; Hallowell; Paul; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 137-43(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Studies of scintillation TlCl(I,Be) crystals were conducted using 8-GeV negative pions and 50- to 130-MeV positrons. Pulse shapes and resolutions of these crystals were measured. Pulses from TlCl(I,Be) were observed to have a fast rise time (≤2 ns) and a complicated decay scheme consisting of at least three separate components. Attempts were also made to observe the Cherenkov radiation from these crystals due to highly relativistic particles. The resolution of the pulse height spectrum for a 2.9-cm diameter by 3.8-cm length TlCl(I,Be) scintillator was measured for 8-GeV negative pions. For comparison, the resolution of the same size CsI(Tl) scintillator was measured using the same experimental configuration. The resolution of CsI(Tl) is only slightly greater than theoretical prediction. The resolution of TlCl(I,Be) is greater, being limited by photon statistics even for 35 MeV of deposited energy. The resolution of a 7.6-cm diameter by 7.6-cm length TlCl-(I,Be) crystal used as a Total Absorption Shower Counter for 50- to 130- MeV positrons was also measured. This resolution is in reasonable agreement with previously reported data. (16 figures, 3 tables) (auth)

12159 WIRE COUNTERS WITH A NEW GAS MIXTURE. Atac, M. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 144-7(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A multiwire chamber using a gas mixture of argon, 2-methylpropane, and 1,1,1-trichloroethane ($CH_3 \cdot CCl_3$) was operated successfully. Although this chamber does not operate in the proportional mode (i.e., pulse height is not a linear function of the primary ionization), it has a substantial advantage over conventional proportional chambers, especially when it is used to detect high-energy particles. These detectors are called wire counters; their unique feature is in the use of a highly electronegative substance, $CH_3 \cdot CCl_3$, to limit the electron avalanche. These counters with wire spacing of 1 mm can provide gas multiplication factors between 10^5 to 10^7 without going into spark formation or breakdown. Their detection efficiency approaches 100% with large high voltage plateaus. A time resolution of ±6 ns at fwhm from pulses with rise times between 6 and 10 ns was obtained. (8 figures) (auth)

12160 COAXIAL AND PRINTED CIRCUIT DELAY LINES FOR MULTI WIRE PROPORTIONAL CHAMBER READOUT. Boyd, D. P.; Rand, R. E.; Rothbart, G.; Barth, E. (Stanford Univ., CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 148-51(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Delay lines have been shown to offer many advantages for multiwire proportional chamber readout, particularly in applications involving single-event counting. It is desirable to optimize the delay line with respect to cost, mechanical convenience, linearity, and rise time. Several types of tapped delay lines were constructed and tested with a 20 × 20 cm proportional chamber. A delay line constructed of 100 1-meter lengths of RG-316/U miniature coaxial cable offers excellent linearity (<0.2%), a rise time of 30 ns, and total delay of 500 ns. Printed circuit delay lines, with characteristics similar to the coaxial lines, were constructed; they offer greatly improved packaging properties at a cost of less than $1 per wire. (7 figures, 1 table) (auth)

12161 SOME RECENT PROGRESSES IN PARTICLE DETECTION. Charpak, G. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 152-7(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Recent developments in European laboratories indicate that the use of proportional or semiproportional gaseous amplification can lead to detectors which are competitive with many existing devices for spatial accuracy, time resolution, and cost. A number of these are discussed. Three systems with 5000 wires are running successfully at CERN. All have wire spacings of 2 mm; the largest is about 3 m long. A three-coordinate system with 50,000 wires, which is under construction, is described. The use of "magic gas" and its attendant advantages are discussed; it was learned that appropriate mixtures can be found to enable the use of magic gas in parallel-plate counters. Use of the time–position correlation may result in the spectacular development of drift chambers: preliminary results indicate a fwhm of 0.16 MeV for a 1-GeV spectrometer. A dramatic improvement in spatial resolution may be possible through the use of a number of thin gas lasers; accuracy is expected to improve as the square root of the number of layers. Operation of a heptane-filled multiwire proportional chamber at very low pressure enables localization and time-of-flight measurements of heavily ionizing recoils. Two methods for reducing costs are briefly described. (10 figures) (R.W.R.)

12162 CHERENKOV LIGHT COLLECTION IN THE HIGH ENERGY ASTRONOMICAL OBSERVATORY: A COSMIC RAY EXPERIMENT. Arens, J. F. (Goddard Space Flight Center, Greenbelt, MD); Balasubrahmanyan, V. K.; Ormes, J. F; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 158-60(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The development of large-area, high-resolution, charge-sensitive detectors for studying the composition of high-energy cosmic rays is described. An important part of the detector is a large-area (50 cm × 50 cm) Cherenkov radiator, which responds linearly to the square of the charge of a particle over the range Z = 1 to 30. A method of achieving fairly uniform light collection efficiency is to place the radiator in a white box; the best white reflector found was $BaSO_4$. The box is viewed through ports of PMT's, and the optimum positioning for the PMT's was studied. Various surface treatments for increasing the light emitted from the radiator are discussed. (5 figures) (R.W.R.)

12163 APPLICATION OF SYNCHROTRON RADIATION FOR THE IDENTIFICATION OF ELECTRONS IN HIGH ENERGY BEAMS. Busza, W.; Chen, M.; Luckey, D. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods; 105: No. 3, 613-15(1972).

Calculations show that, by detecting the energy radiated by an electron in a beam transport magnet, it is possible to identify electrons in the presence of pions in beams of momentum ≳50 GeV/c. (2 figures, 1 table) (auth)

12164 TOTAL ABSORPTION SPECTROMETER FOR ENERGY MEASUREMENTS OF HIGH-ENERGY PARTICLES. Engler, J.; Flauger, W.; Gibbard, B.; (and others) (CERN, Geneva). Nucl. Instrum. Methods; 106: No. 1, 189-200(1973).

A sampling total-absorption counter (STAC) is described which consists of a sandwich of iron and scintillator plates. It permits the energy determination of neutrons or other strongly interacting particles with energies above 3 GeV. The optimization of the energy resolution and other properties of the counter are reported. At 24 GeV/c an energy resolution of ±11% was achieved. (14 figures) (auth)

12165 CONSTRUCTION AND PERFORMANCE OF 1 m x 1 m MULTIPLE WIRE PROPORTIONAL CHAMBERS. Burns, K. B.; Grummon, B. R.; Nunamaker, T. A.; Mo, L. W.; Wright, S. C. (Univ. of Chicago). Nucl. Instrum. Methods; 106: No. 1, 171-80 (1973).

The mechanical construction and electronics of 1m × 1m multiple wire proportional chambers are described. The wire spacing is 1.5 mm. Operating characteristics and performance are presented. (12 figures) (auth)

12166 DATA ANALYSIS TECHNIQUES IN HIGH ENERGY PHYSICS. Jobes, M.; Shaylor, H. R. (Univ. of Birmingham, Eng.). Rep. Progr. Phys.; 35: No. 10, 1077-1172(1972).

An account is given of the reduction and analysis of data from bubble chambers. The principles of operation and the important advances in the bubble chamber technique are briefly described. Since the discovery of the bubble chamber principle, chamber volumes have increased in two decades by a factor of 10^6. The development and construction of manual and automatic machines in the last 20 years are considered. At the present time semi-automatic CRT machines are proving most successful. It is thought that specialized processor hardware may eventually offer the solution to complete automation. The geometrical reconstruction, kinematical fitting and statistical analysis of bubble chamber events are described. The problems of geometrical reconstruction in the present generation of chambers caused by the use of wide angle photography are discussed. A description of the common methods of presenting bubble chamber data and some of the mathematical techniques used in the analysis are also given. (UK)

12167 FALSE PEAKS AND RESONANCE NARROWING DUE TO VARIABLE RESOLUTION. Pisut, J. (CERN, Geneva); Roos, M.; Bohacik, J.; Lichard, P. Nucl. Phys.; B51: 365-76 (1973).

Circumstances are described in which a variable resolution (typically present in counter experiments) may distort resonance shapes, so that they appear to be narrower, or when false peaks may be created in otherwise flat distributions. The effect is illustrated with simplified examples, and with the CERN missing-mass spectrometer of 1966-67. Although the effect is present in the CERN experiment, it is not found to be adequate to account for the narrowness of the observed peaks. (auth)

12168 ON-LINE COMPUTER SYSTEM FOR TRACK CHAMBER FILM MEASURING DEVICES. Alexander, G.; Grunberg, J.; Meir, A.; (and others) (Tel-Aviv Univ., Israel). Nucl. Instrum. Methods; 105: No. 3, 525-31(1972).

An on-line system used for measurements of track chamber pictures in elementary particle physics research is described. The system was designed and built to accommodate Instruments for Evaluation of Pictures (IEP), and consists of an XDS Sigma 3 computer, a RAD disc, typewriters, and a magnetic tape unit. The main purposes of the on-line system are to speed up the measuring rate and to reduce the failure rate, from about 30%, by one order of magnitude. (5 figures) (auth)

12169 RECENT PROGRESS ON TRANSITION RADIATION MEASUREMENTS AND ITS APPLICATION TO THE DETECTION OF ULTRARELATIVISTIC PARTICLES. II. DETECTORS AND MEASUREMENTS. Yuan, L. C. L. (Brookhaven National Lab., Upton, NY). pp 1505-12 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A preliminary study of the measurement of the transition x-ray intensity was made by means of multiwire proportional chambers. Results were obtained with a multiwire chamber stack consisting of from one to four chambers and a chamber-radiator sandwich configuration with varying numbers of sandwich elements. Various radiators similar to those stated above were used and the spectra of the detected x-rays were obtained. A feasibility study was made, based on these results, on the design of a sandwich detector for the measurement of γ of ultrarelativistic charged particles. Methods for the elimination of the dE/dx of the charged particle in the measurement of x-ray transition radiation are described. Measurements of the total yield of x-ray transition radiation with a large NaI detector were also made and measurements of the x-ray spectra and the number of x-ray photons for different thicknesses of radiator materials were obtained. (auth)

12170 LARGE POSITION-SENSITIVE PROPORTIONAL COUNTER. Takahashi, T. (Osaka City Univ.). pp 1524-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A cylindrical proportional counter (diameter 10 cm, length 5 m) with the anode of material with suitable resistance (diameter 0.6 mm nichrome wire) was constructed in order to detect ionization bursts. Energy losses in the counter and position of incident charged particles were determined from the sum and the ratio of the currents at the detector ends respectively. This gave a good linearity and a spatial uncertainty of 10 cm FWHM (2% of the counter length) for cosmic ray muons. (auth)

12171 SATURATION OF PROPORTIONAL COUNTERS USED FOR AIR SHOWER DENSITY MEASUREMENTS. Prescott, J. R.; Spence, G. D. Jr. (University of Calgary, Can.). pp 1528-32 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The proportional counters used by The University of Calgary in previous experiments on air shower density spectra have been tested with bursts of 88 MeV electrons generated by a linear accelerator. The onset of saturation is observed and an upper limit of 15% is set for the amount by which densities may have been underestimated. It is concluded that the steepening of the density spectrum previously observed is genuine and not merely an artifact of the apparatus. (auth)

12172 NEON FLASH TUBES AS ENERGY LOSS MEASURING DEVICES. Diggory, I. S.; Earnshaw, J. C.; Hook, J. R.; Turver, K. E. (Univ. of Durham, Eng.). pp 1533-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The response of neon flash tubes to protons and mesons of known momentum in the range 0.1 to 10 GeV/c has been measured. Neon flash tubes are shown to be satisfactory as indicators of energy loss and their performance is in substantial agreement with expectation on the basis of the model for flash tube behavior suggested by Lloyd (1960). (auth)

12173 SENSITIVE TIMES OF NEON FLASH TUBES. Holroyd, F. W.; Breare, J. M. (Univ. of Durham, Eng.). pp 1538-42 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Measurements of the efficiency of particle detection in flash tubes as a function of the time delay between the passage of the particle and the application of the high voltage pulse show that the sensitive time is reduced by the use of long H. T. pulses and high repetition rates, and this is shown to be due to clearing fields caused by charge separation. The light output from flash tubes, of length 1 m, internal diameter 1.6 cm and gas pressure 600 torr, has been studied and its duration found to be approximately 1 μs and to be independent of the duration of the H. T. pulse, which is normally much longer than 1 μ sec. It is proposed that during the period of the light pulse, electrons are deposited on the glass and these bias off the applied field, thus limiting the discharge. The magnitude of the clearing field is a function of the H. T. pulse length and depends on the number of positive ions deposited on the glass. Measurements of the decay constant of these charges gave a larger value than that predicted assuming the normal value of surface resistivity, 10^8 ohm. (auth)

12174 NEON FLASH TUBE ARRAYS AS TRAJECTORY DEFINING ELEMENTS FOR HEAVY NUCLEI. Andrews, D.; Corydon-Petersen, O.; Funch, O.; Rotenberg, M. (Danish Space Research Inst., Lyngby). pp 1543-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

An instrument for measuring track coordinates of heavy primary cosmic ray particles which consists of layers of neon flash tubes is described and results of a balloon flight are discussed. (auth)

12175 MULTIPLE PARTICLE EFFICIENCY OF A DETECTOR WITH FINITE RESOLVING POWER. Blake, P. R.; Ferguson, H.; Nash, W. F. (Univ. of Nottingham, Eng.). pp 1549-52 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The problem of correcting density measurements made by visual detectors with finite resolving power (e.g. flash-tube and spark chambers) is considered. A method of accurately assessing the correction factors is described. Application of this method to a particular problem associated with the Nottingham EAS experiment at Haverah Park is demonstrated. (auth)

12176 BALLOON-BORNE SPARK CHAMBER AND TIME-OF-FLIGHT DETECTOR FOR HIGH ENERGY ATMOSPHERIC AND SOLAR NEUTRONS. Zych, A.; Albats, P.; Frye, G. (Case Western Reserve Univ., Cleveland). pp 1554-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The detection of cosmic ray neutrons in the energy interval between 10 and 200 MeV is important for the understanding of two diverse astrophysical processes: (1) the mechanism whereby particles are accelerated to relativistic velocities in solar flares, and (2) the method for injecting trapped protons into the inner Van Allen belt. In spite of intensive experimental effort during the last decade no positive identification of solar neutrons has been made, and the albedo neutron flux over this energy range has not been measured. A new type of neutron detector which can unambiguously determine the neutron energy and direction from an extended source is described. Thus the atmospheric neutron intensity can be measured as a function of energy, direction, and atmospheric depth, yielding the albedo flux. The inherent angular resolution makes possible a more sensitive search for solar neutrons. (auth)

12177 OPERATIONAL EXPERIENCE WITH A SPARK CHAMBER-EMULSION MAGNET SPECTROGRAPH. Damle, S. V.; Pal, Y.; Rengarajan, T. N.; Tandon, S. N.; Verma, R. P. (Tata Inst. of Fundamental Research, Bombay). pp 1565-9 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Operational experience with a magnet spectrograph using wide-gap spark chambers and photoplate co-ordinate recorders, used in two balloon flights, is described. Tracks of helium and heavy nuclei and minimum ionizing particles have been traced to the emulsion plate from spark chamber pictures. The mean deviations between the predicted and measured positions and angles are ~400 μm and 5 mrad for this flight system. (auth)

12178 BALLOONING WITH SUPERCONDUCTING MAGNETS. Golden, R. L. (Manned Spacecraft Center, Houston, TX); Adams, J. H.; Deney, C. L.; (and others). pp 1571-6 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A 12'' single-coil superconducting magnet has been flown successfully four times in four tries, including two flights from Parana, Argentina. Details of the magnet construction are presented. It has been found that the field nonuniformities are completely calculable and use of a Helmholtz pair is of no advantage in many applications. Techniques and circuitry are presented for charging the magnet, maintaining it in launch-ready conditions, flying it, and shutting it off inflight. Safety procedures are also discussed. (auth)

12179 SUPERCONDUCTING MAGNET ADDITION TO THE ECHO LAKE EXPERIMENT. Bussian, A. E. (Univ. of Michigan, Ann Arbor); Jones, L. W.; Lyon, D. E.; (and others). pp 1583-6 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The Echo Lake Cosmic Ray Experiment has been modified to include a 1.3 tesla-meter superconducting magnet over the 2000 liter liquid hydrogen target and ionization calorimeter. New spark chambers of four 20 cm gaps each will permit momentum determinations with a M.D.M. of perhaps 4 TeV/c. The admittance of the system including the magnet will be 0.1 m^2sr, although hydrogen interactions will still be collected with the 1 m^2sr of the older system. Properties and preliminary tests of the system are described. (auth)

12180 COSMIC RAY SPECTROGRAPH AT HONG KONG. Lau, K. S.; Ng, K. L.; Young, E. C. M. (Univ. of Hong Kong). pp 1587-90 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A description is given of the design of a solid iron cosmic ray spectrograph which has been constructed at Hong Kong to measure the muon spectrum at sea level up to momenta of approximately 1000 GeV/c. This spectrograph is at present operated in the vertical direction. Neon flash tubes are used to locate the trajectory of the muon. The acceptance rate of the instrument is in the region of 5000 particles per day. (auth)

12181 PRECISION OF MOMENTUM MEASUREMENTS WITH A MAGNETIC SPECTROMETER. Frohlich, A. (Tel-Aviv Univ., Israel). pp 1591-5 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Methods of analyzing the data from magnetic spectrometers are examined. The effects of Coulomb scatter counter efficiencies and assumed spectrum exponent on the observed spectra are considered, and how they might be incorporated into the analytic methods used for correcting the measured muon flux and charge ratio. (auth)

12182 DEIS-PROJECT, A 7 TeV MUON SPECTROMETER. Alikofer, O. C. (Univ., Kiel); Carstensen, K.; Dau, W. D.; (and others). pp 1596-1601 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A new muon spectrometer was designed and is being constructed combining the advantages of multilayer and conventional spectrometer types. The assembly consists of 6 solid iron magnets each $0.5 \times 1.8 \times 3.7$ m^3 and 28 wire spark chambers each 6 m^2 with magnetostrictive readout. A mdm of more than 7 TeV/c and an acceptance of 1500 cm^2sr are expected. The spectrometer will be operated at sea level at Tel Aviv at a mean zenith angle of 85° and will also be used for the study of high energy muon interactions in connection with a separate calorimeter. This is a joint project of the Universities of Kiel and Tel Aviv. (auth)

12183 SATELLITE EXPERIMENT FOR DETECTING LOW ENERGY HEAVY COSMIC RAYS. Hovestadt, D.; Vollmer, O. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). pp 1608-13 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A combination of a flat thin window proportional counter and a solid state detector is used as a dE/dx vs E device. The energy ranges are: for protons 0.3 to 2.5 MeV, for alpha particles 0.2 to 2.5 MeV/nucleon, and for Iron 60 keV/nucleon. The geometrical factor of 1.27 cm^2 ster is sufficient to detect heavy solar cosmic rays. (auth)

12184 USE OF A MODIFIED IGY NEUTRON MONITOR TO MEASURE THE ENERGY SPECTRUM OF NUCLEAR ACTIVE PARTICLES. Dixon, H. E.; Jenkins, I. A.; Mamidzhanyan, A. E.; Maslin, G. C.; Turver, K. E. (Univ. of Durham, Eng.). pp 1643-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The multiplicity spectra of neutrons from a modified IGY monitor have been recorded for: (1) all incident cosmic rays at sea level (predominantly neutrons of energy about 200 MeV); (2) near vertically incident single cosmic ray protons and pions of known momentum in the range 1-30 GeV/c; and (3) nuclear active particles in small air showers (typically protons and pions of energy ~10 GeV). On the basis of these data, attempts have been made with a knowledge of the estimated monitor efficiency to determine the numbers of evaporation neutrons produced in the monitor by incident particles of differing energy. The possibility of using the monitor multiplicity distributions as a useful indication of the energy spectrum of the incident particles is investigated with particular reference to measurements of nuclear active particles in EAS. (auth)

12185 DETECTION OF X-RAY TRANSITION RADIATION OF 31-GeV ELECTRONS. Alikhanyan, A. I.; Kankanyan, S. A.; Oganessyan, A. G.; Tamanyan, A. G. (Erevan Physical Inst., USSR). Phys. Rev. Lett.; 30: No. 3, 109-11(15 Jan 1973).

An improved method of particle detection is described, utilizing both the x-ray transition radiation and the ionization of a gas by the particle. (auth)

12186 IDENTIFICATION OF RELATIVISTIC PARTICLES WHOSE TRACKS ARE VERY INCLINED IN NUCLEAR EMULSIONS. Virk, H. S. (Univ., Paris). Compt. Rend., Ser. B; 275: No. 14, 517-19(2 Oct 1972). (In French).

The grain density of relativistic particle tracks in nuclear emulsions was analyzed. For inclined tracks a correction is proposed to allow the identification of the particles involved. (France)

Radiometric Instruments

12187 (AD-745566) DEVELOPMENT OF A ZERO-G GAUGING SYSTEM. Special Technical Report, January 11, 1971-February 25, 1972. Bupp, F. E. (TRW Systems Group, Redondo Beach, Calif.).

Mar 1972. Contract F04611-71-C-0010. 9p. (AFRPL-TR-72-36). NTIS.

The ultimate objective of this project is the development of a zero-g gauging system based on the absorption of gamma radiation. The numerous subsystem parameters of a nucleonic gauge were interrelated in closed form and subjected to appropriate tradeoff analyses and optimization routines to synthesize gauging systems capable of meeting the prescribed performance parameters. Particular emphasis was placed on achieving high levels of accuracy (1 percent or better over the entire range of full- to empty-tank conditions) with gauges configured completely external to spherical tanks fueled with cryogenic fuels. Nucleonic gauges capable of meeting the prescribed requirements were subjected to preliminary designs and critical subsystem elements were verified with laboratory testing. (auth)

12188 (AD-746267) INVESTIGATION INTO THE CAUSES FOR THE SHORT LIFETIMES OF GEIGER-MUELLER TUBES USED IN AIRCRAFT OIL GAUGING SYSTEMS. Morin, D. E. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 76p. (GEP/PH-72-14). NTIS. Thesis.

The causes of failure of the G-M detectors used in the nucleonic oil gauging system of USAF aircraft are presented. Experimental tests performed on several tubes, in simulated aircraft environments, proved that the detectors fail because of a depletion of the halogen quench gas. A variety of surface analyses established that the halogen gas reacted with both the cathode and anode surfaces. On the cathode the halogen (bromine) attack was always co-located with lead deposits and the only known source of lead inside the counter is from the glass solder used as the tube sealant. Recommendations are made to increase the G-M tube longevity. Implementing these recommendations requires only minor modifications to the basic system. (auth)

12189 MONTE CARLO STUDY OF NEUTRONS IN MATERIAL FOR SURFACE MOISTURE AND BORON GAUGES. Benedek, S. (Inst. for Electrical Power Research, Budapest). Nucl. Eng. Des.; 22: No. 2, 348-58(1972).

Problems of determining the moisture content in materials and the boron content in water by means of a neutron reflection method are studied. The main purpose of the investigations was to solve the problem of moisture measurement for materials of small layer thickness. The theoretical investigations were performed by making use of a Monte Carlo method. The theoretical and experimental results support each other well. Some results of calculations and measurements are presented. (auth)

12190 NUCLEAR MOISTURE GAUGE FOR DETERMINATION OF THE RELATIVE HUMIDITY CONTENT IN A MATERIAL. Piene, H.; Sunde, A. (to Institutt for Atomenergi). Norwegian Patent 124,285. 6 Jul 1972. Filed 1 Aug 1968. (In Norwegian).

A nuclear moisture gauge which combines a fast neutron source, a thermal neutron detector, a gamma source and a gamma detector shielded from direct radiation from the source, is described. The gamma detector is connected to a pulse counter which stops at a predetermined number of pulses, and also simultaneously stops the neutron counter. Digital and logic circuits provide a zero corrected, linearized reading which may easily be calibrated to give the value of the moisture content directly in weight percent. (Norway)

12191 INSTRUMENT FOR MEASURING THE THICKNESS OF LAYERS WITH RADIOACTIVE NUCLIDES. Fischer, H. U. S. Patent 3,705,305. 5 Dec 1972. Priority date 10 Aug 1970, Germany.

An instrument for measuring the thickness of layers by means of radiation emitted from radioactive nucleides which interact with material of the layer and are then absorbed by a radiation detector is described. A sighting mechanism determines the area of the layer to be irradiated and a diaphragm is interposed between the radioactive nucleide and the layer to define this area. A radiation detector on a supporting device can be moved into and out of a measuring position relative to this area. (auth)

12192 MONTE CARLO CALCULATIONS FOR THE SURFACE GAMMA DENSITY GAUGE. Christensen, E. R. (Technical Univ., Lyngby, Denmark). Nucl. Eng. Des.; 22: No. 2, 342-7(1972).

A Monte Carlo model for the surface gamma density gauge has been set up. The model is based on the principle of similitude. The scattering medium can either be semi-infinite or finite cylindrical. The source is a point source situated at the plane medium surface or at a prescribed elevation above it. The detector area is approximated by the area between two circles in the medium surface, centered at the source. Source collimation can be simulated. The calculations are compared to experiments with the surface gauge IPR 101. Special attention is paid to the influence of source collimation on depth resolution. Good agreement between calculations and measurements is obtained, if maximally two experimentally determined parameters are introduced. The present Monte Carlo model takes the finite extension of the detector area into account in a consistent manner. (auth)

12193 DEVELOPMENT OF RADIOISOTOPE X-RAY FLUORESCENCE ANALYZER AND ITS APPLICATION TO INDUSTRIAL PROCESS. Uchida, Kaoru (First Atomic Power Industry Group, Tokyo). FAPIG (Tokyo); No. 63, 161-5(Nov 1971). (In Japanese).

A compact, radioisotope-sourced x-ray fluorescence analyzer which is stable in primary radiation intensity, has been developed by Ube Kosan in the place of conventional x-ray tube analyzers. It was found that α sources were superior for light elements in excitation rate and S/N ratio than β sources. Computer control of cement raw-material preparation has been achieved in cooperation with Fujitsu and Fuji Electric Manufacturing Co. This analyzer results in a total analysis time of 19 min in the case of wet raw materials. Every absolute standard deviation to each target value of hydraulic modulus, silica modulus, and iron modulus in the raw-material make-up charged to kilns, is now controllable to ±0.010, ±0.040, and ±0.040, respectively. (Japan)

12194 CONTAINER FILL WEIGHT MONITORING SYSTEM. Maxwell, M. (to Colgate-Palmolive Co.). U. S. Patent 3,697,754. 10 Oct 1972. Filed 17 Apr 1969.

An apparatus is described for monitoring the mass or weight of consecutive individual containers moving on a conveyor unit including radiation means spaced from a conveyor unit for subjecting filled containers to a field of nuclear radiation. Suitable detection means detect the amount of radiation not absorbed by the filled containers and correlate this with the fill weight which is then translated to an electrical signal and fed to suitable recording means. (auth)

12195 APPARATUS FOR INSPECTING TUBULAR GOODS USING A RADIATION-FOCUSSING DEVICE FOR PRODUCING A SUBSTANTIALLY UNIFORM COMPOSITE RADIATION PATTERN. Tompkins, D. R. (to Schlumberger Tech. Corp.). U. S. Patent 3,683,186. 8 Aug 1972. Filed 26 Mar 1970.

In the new and improved radiation apparatus disclosed herein for inspecting tubular goods, a radiation detector is coaxially positioned within a tubular member being axially translated along a selected inspection axis for receiving radiation from a uniquely-arranged radiation emitter facing the detector and rotating around the exterior of the tubular member. In the preferred embodiment disclosed herein, this unique radiation emitter includes an array of side-by-side radioactive sources of selected strengths respectively directed inwardly through laterally-spaced, generally-parallel focussing passeges for producing individual sharply-defined radiation beams respectively having a transverse width substantially smaller than that of the active portion of the detector. The outer or flanking sources of the array are arranged in relation to the intermediate source so that the radiation beams of the two outer sources will be directed on opposite sides of the inspection axis and the radiation beam of the intermediate source will intersect the inspection axis. In this manner, lateral movements of the detector to one side or the other of the inspection axis will progressively bring the active portion of the detector into the radiation pattern produced by one of the flanking sources as the detector moves out of the radiation pattern of the intermediate source. Accordingly, by cooperatively selecting and positioning the sources in operative relation to one another and to the detector, a substantially constant radiation intensity will contact the detector when it is at any position within a selected boundary around the inspection axis so that random or erratic shifts of the detector within the moving tubular member will not affect the accuracy of the measurements being obtained. (auth)

12196 METHODS AND APPARATUS FOR INSPECTING TUBULAR GOODS USING A CONTINUOUS SIGNAL CALIBRATING SYSTEM. Tompkins, D. R. (to Schlumberger Tech. Corp.). U. S. Patent 3,683,187. 8 Aug 1972. Filed 26 Mar 1970.

In the new and improved radiation apparatus disclosed herein for inspecting tubular goods, a radiation detector is coaxially positioned within a tubular member being axially translated along a selected inspection axis for receiving radiation from a radiation emitter facing the detector and rotating around the exterior of the tubular member. In the preferred embodiment disclosed herein, a unique radiation-attenuating device or shutter is cooperatively arranged to be normally interposed between the radiation emitter and the radiation detector to at least reduce the intensity of radiation imposed on the detector when a tubular member is not being inspected. The shutter is moved by selectively-operated controls to a second position as a tubular member that is to be inspected is placed between the radiation emitter and detector. In practicing the methods of the present invention with the disclosed apparatus, the shutter is uniquely arranged to cooperate with the detector

circuitry for developing a comparison signal when the shutter is interposed between the radiation emitter and detector. The accuracy of this comparison signal is further assured by providing one or more clamping devices which are uniquely arranged for securing the radiation detector in a selected position when the comparison signal is developed. (auth)

12197 APPARATUS FOR INSPECTING TUBULAR GOODS HAVING GUIDE MEMBERS TO FIX A DETECTOR IN THE CENTER OF THE TUBULAR GOODS. Hugonin, G. H. (to Schlumberger Tech. Corp.). U. S. Patent 3,683,188. 8 Aug 1972. Filed 26 Mar 1970.

In the new and improved radiation apparatus disclosed herein for inspecting tubular goods, a radiation detector is adapted to be received within a tubular member being axially translated along a selected inspection axis for receiving radiation from a radiation emitter facing the detector and mounted in a body rotating around the exterior of the tubular member. To assure that the detector will remain coaxially positioned within a tubular member with a minimum of erratic movements in relation thereto, the detector is supported by fixed, depending slides which are adapted to be interchanged with other slides as required to correctly position the detector. The ends of the detector housing are uniquely shaped to facilitate the insertion of the detector housing into a tubular member advancing along the inspection axis without reducing the speed of movement of the tubular member. (auth)

12198 RADIATION-RESONANCE NEUTRON DETECTOR FOR GEOPHYSICAL INVESTIGATIONS. Vakhtin, B. V.; Ivanov, V. S.; Novoselov, A. V.; Filippov, E. M. At. Energ. (USSR); 33: No. 5, 928-9(Nov 1972). (In Russian).

A radiation-resonance neutron detector was designed for recording neutrons in the resonance region of elements where the absorption cross section of boron is relatively low (50 to 100 barns). The detector contained a foil of Ag, Rh, In, Tm (or other element capable of resonance capture and γ-quantum emission), and a scintillation counter. In addition, the unit contained a neutron source and a photoelectric multiplier. (K.S.W.)

12199 INSTRUMENT FOR THE INVESTIGATION OF POWDER SAMPLES BY MEANS OF RADIOMETRIC ANALYSIS. Starnes, P. E. (to Hilger and Watts Ltd.). German Patent 1,773,032. 20 Jan 1972. (In German).

The invention is a device which facilitates and improves the radiometric analysis of powdered materials. The material in question is fed onto a moving sample carrier and is spread to form a layer of constant thickness and width, weighed, passed along the radiation source, and removed. The moving sample carrier is a vibration transporter. The weight of the sample (determined by means of a bearing balance which is coupled to the transporter) is shown by an indicator gage. (GF)

12200 IONIZATION CHAMBERS FOR DETECTING FIRES. Gacogne, J. (to Gamma-Electronic). French Patent 2,108,895. 26 May 1972. Filed 16 Oct 1970. (In French).

A device for detecting combustion smoke and gas in the atmosphere is described. The device utilizes the ionization chamber principle. An electrical circuit handles the signals obtained from one or several detectors and detects anomalies which could disturb the operation. A reference chamber is positioned inside the analyzing chamber. This reference chamber is concentric with the analyzing chamber and open at its ends. The positioning of the openings, their orientations and their staggered arrangement are such that the gas or smoke to be detected only reaches this reference chamber after a considerable time lapse in relation to the analyzing chamber, the alarm having already been triggered. The free circulation of air and gas in the reference chamber enables a constant electrical equilibrium to be maintained in the two chambers for slow variations in temperature, pressure and the composition of the air in the controlled parts. (France)

12201 DYNAMIC MEASUREMENT OF THE RELATIVE GAS CONTENTS IN BUBBLE COLUMNS BY MEANS OF X-RAY ABSORPTION. Beinhauer, R. Berlin; Technische Univ. (1971). 171p. (In German).

Thesis.

The suitability of the X-ray absorption method for measuring the relative gas content for determining the macroscopic model parameter of the bubble columns was investigated. The radiation source and detector were set up outside the bubble column reactor. The timely fluctuations of the local gas content were determined by distribution functions (fully automatic analysis of amplitude with a 400-channel analyser) characterized by statistical parameters (mean value, scattering, slope, curvature). An iterative method following the principle of the greatest probability renders the splitting of this distribution into two normal distributions of varying mean values, scatterings and parts for the small bubbles arising from a small flow of gas and big bubbles at large flows, due to fusion of the bubbles, possible. The axial intermixture coefficient (DMK) of the fluid phase is proportional to the product of the fluctuation frequency and the square of the scattering (SQ) of the gas content. The frequency of the gas content fluctuation is a constant of the system and is independent of the gas flow and the height of the column. The DMK and the SQ are directly proportional to one another and this proportionality constant was determined. (HK/LP)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to abstract 12046.

12202 (N-72-26033) SILICON SOLAR CELL DEVELOPMENT AND RADIATION EFFECTS STUDY FOR LOW TEMPERATURE AND LOW ILLUMINATION INTENSITY OPERATION. VOLUME 2. Kirkpatrick, A. R. (Ion Physics Corp., Burlington, Mass.). Jan 1972. Contract NAS2-5516. 49p. (NASA-CR-114429). NTIS.

The results are presented of a study to determine the effect of in-situ proton irradiation upon low temperature, low intensity performance of several cell types. The cell types were selected in an attempt to distinguish variations in temperature-dependent radiation resistance which could be attributed to the n-p or p-n structure, diffused or implanted junctions, crucible grown or float-zone type base material, and high or low base resistivity. The results indicate that while expected variations of performance occur at room temperature, all cell types degrade more or less similarly at lower temperatures with normalized degradation becoming increasingly rapid as temperature is reduced. Recommendations for an optimized cell for Jupiter probe use are included along with a definition of the testing required on these cells to insure good performance characteristics. (STAR)

12203 INFRARED RESPONSE MEASUREMENTS ON RADIATION-DAMAGED Si(Li) DETECTORS. Sher, A. H.; Liu, Y. M.; Keery, W. J. (Inst. for Applied Tech., Washington, DC). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 312-17(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The improved infrared response (IRR) technique was used to compare qualitatively radiation effects on Si(Li) detectors with energy levels reported for silicon in the literature. Measurements were made on five commercial silicon detectors and one fabricated in house, both before and after irradiation with fast neutrons, 1.9-MeV protons, and 1.6-MeV electrons. Effects dependent upon the extent of radiation damage were observed. It seems likely that the photo-EMF, or photovoltage, effect is the basic mechanism for the observation of IRR in p-i-n diodes with a wide i region. Experimental characteristics of the IRR measurement are in agreement with those of the photovoltage effect. (5 figures, 1 table) (auth)

12204 RADIATION DAMAGE EFFECTS BY ELECTRONS, PROTONS, AND NEUTRONS IN Si(Li) DETECTORS. Liu, Y. M.; Coleman, J. A. (Inst. for Applied Tech., Washington, DC). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 346-52(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The degradation of performance of lithium-compensated silicon nuclear particle detectors induced by irradiation at room temperature with 0.6-MeV and 1.5-MeV electrons, 1.9-MeV protons, and "fast" neutrons from a plutonium-beryllium (Pu-Be) source was investigated. In general with increasing fluence, the irradiations produced an increase of detector leakage current, noise, and capacitance and a degradation in the performance of the detector as a charged-particle energy spectrometer. Following the irradiations, annealing effects were observed when the detectors were reverse-biased at their recommended operating voltages. Upon removal of bias, a continuous degradation of detector performance characteristics occurred. Detectors which had been damaged by electrons and protons exhibited a stabilization in their characteristics within two weeks after irradiation, whereas detectors damaged by neutrons had a continuous degradation of performance over a period of several months. (10 figures, 1 table) (auth)

12205 METHOD OF INCREASING THE CURRENT AMPLIFICATION AND THE RADIATION RESISTANCE OF SILICON TRANSISTORS WITH SILICON OXIDE COVER LAYER. Bauerlein,

Rudolf; Uhl, Dieter (to Siemens Aktiengesellschaft). U. S. Patent 3,691,376. 12 Sep 1972. Priority date 31 Jan 1969, Germany.

A method of increasing the current amplification and the radiation resistance of silicon transistors having a silicon oxide cover layer is described. The transistor is first exposed to an ionizing X-ray, gamma or electron radiation of such energy that the silicon oxide layer is penetrated by at least a portion of the radiation at a dose between 10^4 and 10^9 rad. The transistor is subsequently subjected to an electric charge, without radiation effect whereby a blocking-layer temperature of about 50° to 250°C occurs, and the sequence of irradiation and electric charges without radiation is repeated at least once. (auth)

12206 PERMANENT DAMAGE IN TRANSISTORS DUE TO NUCLEAR RADIATION FROM THE VIEWPOINT OF RELIABILITY. Bora, J. S. (Bhabha Atomic Research Center, Bombay). J. Inst. Telecommun. Eng.; 17: No. 12, 470-6(1971).

Permanent changes in the collector-base-cut-off current, emitter-base-cut-off current, input impedance and a.c. gain for indigenous CIL-511 (NPN Si) and BEL-AC128 (PNP 6e) transistors irradiated by the γ and different neutron dose levels are studied. Transistors have been irradiated at CIRUS by a pneumatic carrier facility where the maximum thermal neutron flux is 6.1×10^{13} n/cm^2-sec. Transistors have also been irradiated in the γ environment at a dose of 52.68 Mrads. ^{60}Co is the source of γ radiation, the dose rate being 0.8 Mrads/hr. (Indian Sci. Abstr.)

Miscellaneous Instruments

Refer also to abstracts 12018, 12046, 12130, 12136, 12152, 12325, 12328, 12598, 12956, 13371, 13379, and 13509.

12207 (BNWL-1650(Pt.1), pp 291-4) DEVELOPMENT AND EVALUATION OF BLOOD IRRADIATORS. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Following implantation of intracorporeal irradiators, up to 10 rads/day produces no effect on lymphocyte levels in beagle dogs. Formation of ring thrombi at junctions between the artery and the tubular irradiator discouraged further development of tubular irradiators for permanent implantation. Two new approaches are being developed: one is a wire source to be implanted in the center of a vessel; the other is a portable extracorporeal blood irradiator utilizing an external arteriovenous shunt. Blood irradiation is used to minimize rejection of grafted organs and as a therapeutic measure for some lymphocytic leukemias. Irradiation is now accomplished by utilizing an arteriovenous (A-V) shunt and passing the patient's blood through specially designed gamma or beta irradiators. Because of the heavy shielding required for these irradiators, they are fixed; and the patient must be hospitalized. Inexpensive devices easily carried by the patient would facilitate treatment and extend the clinician's capability to treat more patients. The present effort is directed toward developing such portable devices. (auth)

12208 (CEA-CONF-2051) TECHNOLOGY AND USE OF THERMOCOUPLES OF W-Re ALLOYS. Schley, Robert; Matteudi, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1972. 31p. (In French). (CONF-720661-1). Dep. NTIS (U. S. Sales Only).

From third European conference on thermophysical properties of solids at high temperatures; Turin, Italy (20 Jun 1972).

The different modes of fabrication of thermocouples of W-Re alloy are described. After an examination of the difficulties encountered, each of the components of the thermocouples (the wires, insulators, casings, and the assembly and preparation operations for the hot junctions) is studied. Some concepts on the definition of specifications are derived. Several cases of the utilization of these thermocouples in nuclear and non-nuclear applications are reviewed. It is concluded that numerous problems remain before these thermocouples have a sufficient reliability. (tr-auth)

12209 (COO-3333-1) POSITRON SCANNING WITH COMPUTER INTERFACE. Technical Progress Report, January 1, 1971-October 31, 1971. Brownell, G. L. (Massachusetts General Hospital, Boston. Physics Research Lab.). 6 Dec 1971. Contract AT(11-1)-3333. 19p. Dep. NTIS.

The question of focusing in the positron camera was studied. Although discrete detectors are required to achieve the data rates desired with this instrument, they impose a problem in that a point on the focal plane does not diffuse into a disk off the focal plane but rather into a pattern of discrete points. The simplest solution is a very small amount of motion in one direction of the detector or the object being scanned. The resolution appears better than 1 cm on the midplane, and data may be collected at rates of at least 5×10^5 events per second. The system is used in limited clinical studies. ^{15}O and ^{13}N are used routinely for clinical and biological studies. Development work on production of ^{11}C-labeled compounds is beginning; and various studies, such as increasing the yield of ^{11}C and synthesis of simple organic compounds, are underway. ^{18}F is produced routinely and compounds of this isotope are being developed for pulmonary studies. Hardware and software were developed for the PDP-9 computer system. Data from the positron camera and scintillation camera can be collected on-line, and numerous processing routines are available, including those for adding, subtracting, and averaging images. It was shown possible to correct for absorption effects by measuring a set of transmission images from an external positron source in addition to the original set of emission measurements from the subject. In all cases the three-dimensional reconstruction technique produced results much more accurate than those achieveable by tomographic techniques. (2 figures, 1 table) (RWR)

12210 (COO-3333-2) POSITRON SCANNING WITH COMPUTER INTERFACE. Technical Progress Report, January 1-July 31, 1972. Brownell, G. L. (Massachusetts General Hospital, Boston). 2 Aug 1972. Contract AT(11-1)-3333. 13p. Dep. NTIS.

The positron camera was developed to the point where it is used routinely in research studies and in clinical examinations. It is used to obtain sequential dynamic images on a time scale as small as 0.1 s. The resolution on the midplane is less than 1 cm, and studies are under way with a high-resolution collimator to decrease the resolution distance further. ^{15}O is used as O_2 and CO_2, and ^{13}N has been widely used in pulmonary and cardiac studies. Work on the production of ^{11}C and ^{18}F continued. Images from the positron camera and scintillation camera can be collected on line, processed in a variety of ways, and displayed in a number of modes. Dynamic function data can be extracted from both the scintillation camera and the positron camera images; a variety of display modes for the dynamic curves were developed. (RWR)

12211 (IFVE-SEF-71-45) INVESTIGATION OF A UNIVIBRATOR WITH LINEAR ADJUSTMENT OF THE DURATION IN A WIDE TIME RANGE. Krendelev, V. A.; Uglekov, V. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

A univibratory is described whose nonlinearity in delay adjustment is not higher than ±0.1% at delays from 3 ms up to 3 s, and whose error is less than ±0.2% over a temperature range 0°C to +50°C. The formulas to calculate the delay time, relative nonlinearity of duration adjustment, and temperature instabilities are presented. (5 figures) (auth)

12212 (JUL-885-RG) NOISE THERMOMETRY AS A METHOD FOR TEMPERATURE MEASUREMENT IN NUCLEAR REACTORS. Brixy, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jun 1972. 130p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen (West Germany).

Noise thermometry was developed and tested as a measuring method for precise and reliable temperature measurements in nuclear reactors. In contrast to the thermometers which have been used up to now (thermocouples, resistance thermometers, etc.), the noise thermometer is independent of all environmental influences, such as reactor radiation or atmosphere. It is independent of its previous thermal and mechanical treatment and of the material used. Consequently, the noise thermometer retains its initial precision even after any length of application time. This property is important for applications in nuclear reactors requiring long periods of exposure. Noise thermometry is based on the Nyquist theorem of thermal noise. According to this theorem, a statistically fluctuating voltage, the mean square of which is proportional to the absolute temperature, is generated across the terminals of a passive unloaded network. The amplitude of the noise voltage lies in the range of 10^{-7} and 10^{-6} V. In order to avoid the difficulties of an absolute measurement of these low voltages, a comparison method is used, which was developed as a null method. The noise voltages of two resistors, one being at the unknown temperature and the other at a reference temperature, are compared. If the noise voltages of both resistors are equal, the resistance quotient determines the quotient of the absolute temperatures. During the first noise temperature measurements the electronic measuring equipment was tested. An accuracy of 0.1% could be reached in the range of 300°K and 1200°K. Noise temperature measurements were carried out in fuel element positions in the FRJ-2, and it was experimentally proved that even an intense reactor radiation does not influence the function of the noise thermometer. For these mea-

surements, a fully transistorized measuring equipment was used, in which the noise of the amplifier was eliminated by cross correlation. The measuring sensor was heated up by the gamma radiation of the reactor, and the temperature could be varied within certain limits by the gas supply of the measuring rig. The thermal-neutron flux at the sensor position amounted to 6×10^{13} nv, and the gamma flux amounted to 2.5×10^{8} R/h. A series of measurements was carried out in the range of 300°K and 500°K where all the noise temperatures were within the range of a calibration accuracy of 0.5% of the reference thermocouples. At the end of the experiment (duration: 3 reactor periods), the noise thermometer had been exposed to an integral thermal-neutron flux of 3×10^{20} nvt, and the noise resistance had changed by 6%. The operating capacity of the noise thermometer had, of course, not been impaired in any way by this process. The experiment also showed that the noise thermometer is applicable even at long distances between thermometer and amplifier (in this case, 18 m) and in an environment with intense electromagnetic interference fields. Noise thermometry can, therefore, be used as a measuring method under rough conditions in nuclear reactors. (51 figures, 3 tables, 76 references) (auth)

12213 (LA–5103) LASL COMPUTER NETWORK. Christman, R. D. (Los Alamos Scientific Lab., N. Mex.). Dec 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

The network being developed at the Los Alamos Scientific Laboratory will link together several large (super) computers, a large data base (10^{12} bits), and a variety of remote computers and terminals. The major goals of the network are to provide a common data base for all users and computers and a significant remote terminal capability. The technical aspects of the network hardware are described along with the design and implementation experience and the projected costs. (auth)

12214 (LA-DC–72-1347) ON-LINE DIAGNOSTIC TECHNIQUE TO IMPROVE INSTRUMENTATION SYSTEM AVAILABILITY. Helmick, H. H. (Los Alamos Scientific Lab., N. Mex.). [nd]. 9p. (CONF-721123–1). Dep. NTIS.

From IAEA specialists' meeting on application of reliability analysis to control and instrumentation systems; Kjeller, Norway (30 Nov 1972).

The variance-to-mean ratio method of determining the degree of nonrandomness in pulse counting systems can be used in a monitoring capacity to provide identification of an incipient instrumentation fault prior to total loss of that channel. The inherent reliability of the data channel is not altered, but repairs can be made and the channel becomes available sooner than if the incipient fault is detected during normal maintenance inspection. Although usually thought of in the pulse counting context, variance-to-mean is also applicable to time-integrated samples of an analog signal. (4 figures) (RWR)

12215 (LBL–1(Vol.1)) INSTRUMENTATION FOR ENVIRONMENTAL MONITORING: AIR. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1 May 1972. 283p. Dep. NTIS.

The National Science Foundation has engaged the Environmental Instrumentation Group of the Lawrence Berkeley Laboratory (formerly Lawrence Radiation Laboratory) to conduct a survey of instrumentation for environmental monitoring. Instruments being investigated are those useful for measurements of Air, Water, Radiation, and Biomedicine related to environmental research and monitoring. Consideration is given to instruments and techniques presently in use and to those developed for other purposes but having possible applications to this work. The results of the survey include descriptions of the physical and operating characteristics of available instruments, critical comparisons among instrumentation methods and recommendations for the development of new instruments, and of promising methodology. The survey material is compiled in four loose-leaf volumes which will be periodically updated. Volume 1 as initially issued covers Sulfur Dioxide monitoring; additional sections on Oxides of Nitrogen, Photochemical Oxidants, Mercury, Lead, Beryllium and Asbestos will be issued during the year. (auth)

12216 (LBL–1312) NEW TECHNOLOGIES. Mack, D. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1972. Contract W-7405-eng-48. 57p. (CONF-721057–1). Dep. NTIS.

From Business and environment seminar; Disneyland, FL (16 Oct 1972).

Methods and equipment for x-ray fluorescence spectroscopy, microwave spectroscopy, and nuclear magnetic resonance analysis of environmental samples are briefly reviewed. Also, topics on the systems approach to data handling including NIM, CAMAC, remote data handling facilities, displays, and data information centers are discussed. (W.H.K.)

12217 (SGAE–2047) FOCAL CONTROLS CAMAC. May, F.; Halling, H.; Marschik, W.; Petreczek, K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronikinstitut). Oct 1972. 13p. Dep. NTIS (U. S. Sales Only).

An overlay for FOCAL DEC-08-AJAE-LA has been developed to allow data and command handling (FOCADAT) with CAMAC systems. This overlay program (FOCADAT) has been extended now by an additional program (FOCALINT), which enables FOCAL to execute interrupt handling for CAMAC as well. The complete system is well suited for test- and control-purposes of special CAMAC modules and rather large control systems. CAMAC is an international standardized computer independent interface system for computer application in measurement and control. This system is specified by the EURATOM reports EUR 4100 and EUR 4600. (auth)

12218 (UCID–15534) COMMON MODE REJECTION WITH GUARDING. Allen, L. R. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Jul 1968. 6p. Dep. NTIS.

Ground currents were long a severe headache with data acquisition systems. With the advent of the guarding procedure, however, the problem is no longer the chief limitation on accuracy and resolution. Certain rules must be followed to realize the advantages of guarding, and these rules are collected and explained in this paper. (3 figures, 1 table) (RWR)

12219 (UCRL–51130(Vol.2)) FINAL REPORT ON THE DEVELOPMENT OF THE GEOGRAPHIC POSITION LOCATOR (GPL). VOLUME 2. EXECUTIVE SUMMARY. Salisbury, J. D. (California Univ., Livermore. Lawrence Livermore Lab.). 2 Nov 1972. Contract W-7405-Eng-48. 20p. Dep. NTIS.

The Geographic Position Locator (GPL) is a small, self-contained, unaided system for accurate, long-term, land-based inertial navigation. It uses the normal rest periods of land-based systems to reduce system errors and improve the subsequent navigational accuracy. Operation can be fully automatic, with a motion-state sensor activating the error-reduction process during stationary periods. Stored map information for automatic comparison with computed position, and selective response based on the comparison, also could be part of a fully automated GPL system. Possible use of the GPL with nuclear weapons was the primary motivation of our program. The techniques developed, however, apply to other navigation systems where the mission includes occasional stops and external references are unavailable. (auth)

12220 NEGATIVE ELECTRON AFFINITY MATERIALS IN PHOTOMULTIPLIERS. Williams, B. F. (David Sarnoff Research Center, Princeton, NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 39–44(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Since their introduction as laboratory devices around 1967, negative electron affinity (NEA) electron emitters have found many applications for low-light-level detection. Over forty types of photomultiplier tubes with NEA materials are available for detection of light from the ultraviolet to the near infrared. These devices provide useful photosensitivity to 1.1 micrometers. The detectors which are currently available are reviewed, and the prospects for the near future are discussed. A general summary of the contribution of NEA materials to low-light-level detection is included. (11 figures, 1 table) (auth)

12221 RECENT WORK ON FAST PHOTOMULTIPLIERS UTILIZING GaP(Cs) DYNODES. Krall, H. R.; Persyk, D. E. (RCA Corp., Lancaster, PA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 45-9(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

There exists an increasing demand for photomultipliers with better time resolution, higher count rate capabilities, and generally faster time response. Fundamental electron-optical considerations which determine the speed of response of electrostatically focused photomultipliers are presented. The nature of time broadening is discussed with regard to geometrical and initial velocity effects at dynode surfaces. Time limitations inherent in the dynode material itself are also treated. Examples of different fast photomultiplier structures are given. A discussion of various delta-function light sources is included; and the relative merits of these sources with respect to time performance, ease of use, and cost are reviewed. (6 figures, 1 table) (auth)

12222 PERFORMANCE STUDIES OF PHOTOMULTIPLIERS HAVING DYNODES WITH GaP(Cs) SECONDARY EMITTING SURFACE. Leskovar, B.; Lo, C. C. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 50–62(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Characteristics of photomultipliers having dynodes with cesium-activated gallium phosphide secondary emitting surfaces were investigated. Measurements of characteristics, generally not available from manufacturers' data sheets, for several 8850's, C70133B's, 8852's, and C31024's are presented. The transit-time difference, the single-electron transit-time spread, and the collection and quantum efficiency uniformity as a function of the position of the photocathode sensing area are measured and discussed. Measurement techniques and descriptions of measuring systems are given in detail. Emphasis is put on the determination of optimum photomultiplier operating conditions, particularly concerning the collection efficiency, and minimum transit-time spread. (22 figures) (auth)

12223 MICROCHANNEL PLATE IMAGING DETECTORS. Ruggieri, D. J. (Varian Associates, Palo Alto, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 74-84(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The microchannel plate is emerging as a versatile, high-gain, low-noise, high-speed electron multiplier for use in various image intensifier applications as well as CRT display systems and quantum event imaging detectors. In the case of low-light-level image intensifiers, high-light-level resolutions in excess of 30 Lp/mm and low-light-level resolutions of greater than 10 Lp/mm are routinely achievable. These resolutions are normally achieved with the microchannel plate operating at electron gains of 10^3 to 10^4, with an electron equivalent input noise to 10^{-16} to 10^{-17} A/cm^2. Spatial noise is virtually nonexistent over a wide operating gain region. When used in tandem, uniform gains in the order of 10^6 to 10^7 over an active area of 33 mm have been routinely achieved with background noise counts less than 1.5 counts/sec-cm^2. (17 figures) (auth)

12224 PHOTOMULTIPLIER CONTROL BY A CLAMPING CROSS-BAR GRID. Boutot, J. P.; Pietri, G. (Laboratoires d'Electronique et de Physique Appliquee, Limeil, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 101-6(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The possibilities for locating light events randomly distributed in a plane by using only one photomultiplier with original electron optics are considered. This experimental 2-inch phototube allows a spatial and temporal control of the electron emission from small elements of the photocathode. The originality of the tube lies in the use of a cross-bar control grid embedded in the glass of the window at a short distance (d = 1 mm) from the photosensitive layer. The amplitude of the anode signal obtained in response to a light flash is dependent on the electrical voltage applied to the X or Y wire of the grid associated with the excited element of the photocathode. In such a way it was shown that the position of a point light source scanning the photocathode plane of the PM could be determined with a resolution of 5 mm. Some results obtained by using a coding process to supply the blocking electrical pulses are given. (13 figures) (auth)

12225 WAVELENGTH DEPENDENCE OF PHOTOMULTIPLIER SINGLE ELECTRON RESPONSE AMPLITUDE SPECTRA. Bosshard, R. (Paris Univ. Orsay, France); Rausch, R.; Sauce, M.; Zajde, C.; Amsel, G. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 107-11(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A study of the 56 AVP photomultiplier showed that the single-electron-response amplitude spectrum depends on the wavelength of the detected photons. In fact, for 6700-A light a high-quality spectrum, i.e., one presenting a strong maximum, may be obtained by applying well-chosen voltages to the first dynode and by using the positive focusing bias recommended by the manufacturer. A continuous degradation of the spectrum is observed when the wavelength decreases from 6700 A to 3100 A; for blue light there is no maximum any more. It was found that, for an illumination of the central area of the photocathode, the spectra for blue light may be markedly improved by running the focusing electrode at a negative bias with respect to the photocathode. Results concerning peak-to-valley-type figures of merit of the spectra are shown vs focusing voltage for various wavelengths; the implications of these observations are discussed. It seems that these phenomena are not specific to the 56 AVP, as analogous results were observed on the recent 2106 phototube. (9 figures) (auth)

12226 INFLUENCE OF TRANSIT TIME DIFFERENCES ON PHOTOMULTIPLIER TIME RESOLUTION. TIME RESOLUTION MEASUREMENTS WITH XP 1230, 8575, PM 2106 PHOTOMULTIPLIERS. de la Barre, F. (RTC Radiotechnique-Compelec, Suresnes, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 119-21(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The influence of transit time differences due to the photocathode geometry and the influence of nonuniformity of photoelectric yield and collective efficiency of the optical input system on the time resolution of photomultipliers were investigated. Calculations of the contributions of transit time differences were performed, and the theoretical results were compared with the results of experimental measurements. (2 figures, 1 table) (auth)

12227 LOW-NOISE PREAMPLIFIER FOR HIGH COUNT RATES. Kurz, R. (Kernforschungsanlage, Juelich, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 418-22(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A low-noise charge-sensitive preamplifier employing charge restoration after each detector pulse is described. Charge restoration is performed for each pulse by exposing the input FET to an optical flash (produced by a GaAs diode) proportional to the amplitude of the main amplifier output pulse. Special care is taken to eliminate temperature and linearity problems of the GaAs diode. This preamplifier is capable of operating at very high "energy rates," e.g., for 5-MeV radiation at more than 100,000 Hz. (6 figures) (auth)

12228 FAST SINGLE CHANNEL PULSE HEIGHT ANALYZER FOR PRECISION TIMING WITH SCINTILLATION COUNTERS. Bertolaccini, M.; Cova, S. (Politecnico, Milan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 423-30(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

For fast, precision time measurements with scintillation detectors zero-crossing synchronization and fast energy selection on the current pulses from the detector seem in many cases to be the best choice. A fast S.C.A. was developed giving both a zero-crossing and a leading-edge output for timing purposes. Input pulses are analyzed from 4 to 400 mA. The total time slewing of the zero-crossing output is about 150 ps over the whole range of input amplitudes. Particular care was devoted to the logic of the instrument; it was assumed that correct time information would always be carried by the output pulses. Measurements, performed with scintillation detectors, gave a best resolution of 190 ps by using the zero-crossing output and narrow energy selection on both channels. Good results were also obtained with very wide energy selection. (7 figures) (auth)

12229 LOW POWER PREAMPLIFIER-DUAL DISCRIMINATOR FOR PROPORTIONAL COUNTER HODOSCOPES. Rizzo, A. (Space and Tactical Systems Corp., Bedford, MA); Parnell, T. A.; Guenther, G. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 440-3(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A proportional counter hodoscope for measuring particle trajectories in high-energy cosmic-ray experiments is discussed. A significant advantage of proportional counters compared to spark chambers is the inherent ability to measure the trajectory of the heavy primary cosmic rays ($2 < Z$) in the presence of the copious knock-on electrons and delta rays produced by them. To utilize this advantage, a bilevel discrimination system was developed based upon a preamplifier–dual discriminator unit which uses the low-level discriminator to sense all particles and the high-level discriminator to sense only heavy particles. The charge-sensitive preamplifier–dual discriminator–storage units, which are packaged in hybrid thick film form for the hodoscope, consume less than 4 milliwatts of power and weigh only 9 grams. (6 figures) (auth)

12230 REMONT I NASTROIKA ELEKTRONNYKH PRIBOROV YADERNOI FIZIKI. (Maintenance and Adjustment of Electronic Instruments for Nuclear Physics). Pan'kov, S. A. Moscow; Atomizdat (1972). 177p.

The repair and maintenance of vacuum tube instruments designed for use in nuclear physics are discussed in detail. Methods of testing, calibration, and checking of equipment primarily of Russian design and manufacture are described. Schematic diagrams of the circuitry are included. The instrumentation described includes amplifiers, scaling circuits, instruments for recording coincidence-anticoincidence events, count rate meters, amplitude discriminators, vacuum meters, and stable power supplies. (K.S.W.)

12231 MNOGOKANAL'NYE SISTEMY RADIATSIONNOGO KONTROLYA. VYPUSK I. (Multichannel Systems of Radiation Control. Number 1). Nemirovskii, B. V.; Serzhantov, A. P.; Shipulin, V. V. Moscow; Atomizdat (1972). 104p.

Circuit diagrams are given and maintenance problems are discussed for multichannel equipment which finds application in measurement of ionizing radiation, radiometric control, and detection of β and γ radiation. Testing and calibration procedures for repaired equipment are outlined. Russian code designations of the instrumentation discussed are used throughout the book. (K.S.W.)

12232 LINEAR ACCELERATOR RF MASS SPECTROMETER USING FREQUENCY MODULATION. Spoerri, P. A. Brooklyn; Polytechnic Inst. of Brooklyn (1972). 96p. University Microfilms Order No. 72-28,291.

Thesis.

The performance of the rf mass spectrometer using various shapes and amplitudes of the rf waveform was studied by computer simulation. For low rf amplitudes the resolution is very low except for extremely small current efficiencies (.001). The resolution improves with increasing rf amplitude, but with increasing distortion of the ion peak shape due to acceleration of resonant ions out of phase with the applied rf signal. The use of a frequency modulated waveform improves the spectrometer as a linear accelerator, with the energy gain a linear function of rf amplitude. At high rf amplitudes the resolution in the FM case is about half that for the unmodulated sine wave. In the FM mode of operation the time of flight of resonant ions is proportional to the square root of their mass. By gating the ion source and the detector in time a further improvement in resolution is obtained. The ability of the spectrometer to focus a single ion peak in both energy and time offers some advantages over a conventional TOF mass spectrometer. The computer calculations were tested on a commercial mass spectrometer tube using a FM generator with an upper frequency limit of 2 MHz. For the energy gain case, a xenon mass peak was tuned by varying the modulation index of the applied FM waveform. The electronics were not available to test the calculations made for FM using time-gating of the ion source and detector. (Diss. Abstr. Int., B)

12233 COMPUTER CONTROLLED EXPERIMENT FOR ACTIVATION ANALYSIS. Franke, H. F.; Schlurick, T. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 106: No. 1, 15-19 (1973). (In German).

The relative cross sections for different exit channels were determined for reactions induced by bombardment of enriched 0.5-mg/cm^2 targets of ^{46,48}Ti with 36-, 39-, 42-, 46-, and 50-MeV ^{16}O ions. They were obtained from yields of gamma rays from the residual radioisotopes. The experiment was computer controlled by CAMAC electronics. (7 figures) (auth)

12234 TWO CIRCUITS FOR ON-LINE MONITORING OF SPECIFIC LINES IN A GAMMA SPECTRUM. Brunson, G. S.; Curran, R. N.; Just, F. H. (Argonne National Lab., Idaho Falls, ID). Nucl. Instrum. Methods; 106: No. 1, 21-7(1973).

At EBR-II there is a requirement to monitor the inert cover gas (argon) for traces of noble-gas fission products. This is accomplished by means of the gamma spectra taken with a Ge(Li) crystal. The problem of on-line monitoring of specific fission product isotopes is complicated by the presence of activation products (primarily ^{23}Ne and ^{41}A). In order to extract quantitative information on line from the complex total spectrum, two different on-line digital subtract units (ODSU) were designed and tested. One has the advantage of high-speed response (several microseconds); the other has a response time of a few seconds, but has the advantage of deadtime correction. The current emphasis on monitoring effluents for specific activities suggests that these circuits may find wide use. Aside from the original application to gamma analysis, the first type is already being used elsewhere in the laboratory to monitor alpha spectra for plutonium in the presence of a relatively large and varying activity from natural sources. (7 figures, 1 table) (auth)

12235 RESPONSE OF MULTIPLE COLLIMATOR SYSTEMS TO EXTENDED SOURCES. Lent, E. M. (Univ. of California, Livermore). Nucl. Instrum. Methods; 106: No. 1, 29-34(1973).

Straightforward relationships were found for determining the geometrical response of a collimated detector to an extended source; the results are applicable to multiple collimator systems, as well as to nonisotropic sources. The formulas are given in the form of integrals that must be numerically evaluated. (4 figures) (auth)

12236 FAST TIME ANALYZER EMBODYING A HIGH SPEED PLATED WIRE MEMORY. Michikawa, Taichi (Electrotechnical Lab., Tokyo); Yoneyama, Toshikazu. Nucl. Instrum. Methods; 106: No. 1, 35-43(1973).

A fast time analyzer operating in a multiscaling mode with 256 channels and 25 ns minimum channel width was constructed by employing the high-speed plated-wire memory with a 175 ns cycle time for the purpose of its application to pulsed neutron experiments. The characteristic features and details of construction and circuitry of the time analyzer are presented. To test the performance several experiments were carried out. These include measurements of the shapes of the pulsed neutron bursts and measurements of time distributions of thermal-neutron-capture γ rays from various foils in a graphite pile. (13 figures) (auth)

12237 FAST NUCLEAR ELECTRONIC MODULES IN THE CAMAC SYSTEM. Basiladze, S. G.; Gvozdev, V. Y.; Kolpakov, I. F.; Manyakov, P. K.; Tlachala, V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 106: No. 1, 157-60(1973).

A system of fast counter electronics modules is described. The system consists of 7 logic, 5 linear, and 4 signal conversion and control modules. The basic features of the system are mechanical and electric compatibility with CAMAC, analog inputs for control of module parameters, and use of output pulse shapers without count losses during the output pulse length. (4 figures) (auth)

12238 NUMERICAL CONTROL SYSTEM FOR THE ENSEMBLE FOR MEASURING ANGULAR CORRELATION AND DISTRIBUTION. Pfleger, J. C.; Weymann, J. P. (CRN, Strasbourg). Nucl. Instrum. Methods; 106: No. 1, 135-9(1973). (In French).

A flexible and reliable automatic positioning system for two detectors is described. Its main components are two stepper motors and optical encoders, which permit positioning accurate to 0.5 step. The cost of the system is approximately $4000. The main features of the system are described, and a summary of the tests made to verify its operational capabilities is presented. (3 figures) (auth)

12239 PROGRAMMABLE DIGITAL PULSER FOR NMR. Lind, A. C. (McDonnell Douglas Corp., St. Louis). Rev. Sci. Instrum.; 43: No. 12, 1800-10(Dec 1972).

A programmable digital pulser for pulsed NMR applications employing inexpensive integrated circuits is described. This pulser employs two types of modules, one master clock and several counters. The required pulse sequence determines the number of counters to be front-panel interconnected. The master clock module simultaneously provides crystal-controlled clock pulses with periods from 10^{-7} to 1 sec in decade steps. These pulses are used by the counter modules to generate either time delays or pulses with a maximum resolution of five digits. (auth)

12240 DEVICE FOR LOCALIZING BURST SLUGS IN A NUCLEAR REACTOR FUEL ASSEMBLY. Delisle, J.-P.; Rulleau, A.; Prouteau, L. (to Commissariat a l'Energie Atomique). French Patent 2,105,072. 28 Apr 1972. Filed 22 Sep 1970. (In French).

A device for detecting burst slugs in reactor fuel assemblies is presented. The device consists of a plate distributing coolant fluid sampling tubes throughout the assembly. A first selector is traversed by ducts which connect it to several sampling tubes connected to a second selector which interconnects the ducts to a measuring apparatus. The two selectors are supported by a fixed plug for neutron protection. This fixed plug supports a recipient, which controls the delayed neutrons transported by the sampled liquid coolant. A pump controls the circulation of this liquid and a duct returns the analyzed liquid back to the reactor vessel. This device is particularly suitable for fast liquid Na cooled reactors. (France)

12241 HIGH-RESOLUTION MASS SPECTROMETER. Alexandru, Gr.; Dutescu, N.; Molnar, Sibilia (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 6, 765-7(1972). (In Rumanian).

The analytical performance of the mass spectrometer, with a resolution of 2.10^4 at the mass 200 is presented. Two tandem diffusion pumps maintain an operating vacuum of 5×10^{-7} torr. (auth)

12242 INTERPRETATION OF THE MEASURED INTENSITIES IN NEUTRON DIFFRACTION IN THE CASE OF TWO-AXIS ELASTIC DIFFRACTION WITH RISING ARM. Delapalme, A. (CEN, Grenoble, France). Nucl. Instrum. Methods; 105: No. 3, 533-40(1972). (In French).

A simple formalism is defined in order to take into account the influence of the apparatus on the correct interpretation of neutron diffraction data in the elastic case. Existing literature was critically reviewed; the results are applied to a goniometer with rising arm. (5 figures, 1 table) (auth)

12243 PRECISE TIMING METHOD FOR THE DETERMINATION OF SHORT HALF-LIVES. Nunnelley, L.; Boynton, B.; Loveland, W. D. (Oregon State Univ., Corvallis). Nucl. Instrum. Methods; 105: No. 3, 593-4(1972).

A very precise timing technique for the determination of half-lives is described. By using this technique, the half-life of ^{132}Sn was determined to be 40.6 ± 0.8 s. (3 figures) (auth)

12244 PULSE AMPLIFIER FOR PHOTON COUNTERS BASED ON TRANSISTORS. Mamedov, Ya. A. Tr. Shemakh. Astrofiz.

Observ., Akad. Nauk Azerb. SSR; No. 4, 3-5(Apr 1971). (In Russian).

A frequency generator and pulse former were designed into a pulse amplifier on a printed circuit measuring 105 × 38 mm^2 and using SF 136 transistors. This circuit possessed improved amplitude-frequency characteristics for reproducing the slope of the leading front of the pulse. (KSW)

12245 TIME-OF-FLIGHT MASS SPECTROMETER AND ITS APPLICATIONS. Contineanu, M. (Univ. of Bucharest). Stud. Cercet. Chim.; 20: No. 6, 733-49(Jun 1972). (In Rumanian).

The time-of-flight mass spectrometer is one of the most sensitive analytical instruments, able to separate masses very rapidly; ionization of the molecules, acceleration and detection of ions takes place in less than 10^{-4} sec. The resolution of the instruments depends primarily on the ion source. The main components of the system—the ion source, detector, vacuum system and electronic system—are described, followed by a discussion of the application of the spectrometer to the study of reactions induced by lightning photolysis and pyrolysis, shock-wave reactions, gas-phase ion–molecule reactions and interactions of ions with solids. The instrument may be used to identify fractions of gas mixtures separated previously by chromatography. By adding a heated molecular leak inlet system, polymers, such as nylon and various explosives may be investigated. Coupling with a spin electron resonance spectrometer makes it possible to use the instrument to study gas-phase reactions between atoms and molecules. The instrument presents the advantage of fast operation; on the other hand, its resolution is limited. (Review article, 53 references). (TTT)

12246 RELIABILITY TO MOISTURE-PROOF CHARACTERISTICS OF EVAPORATED Zr–N THIN-FILM RESISTORS. Kanou, K.; Shiomi, H.; Mori, F.; Takenouchi, M. Denki Shikensho Iho; 36: No. 7, 525-528(1972). (In Japanese).

Evaporated Zr–N thin film resistors are excellent in durability over a long period of time at various temperatures in moist air. In some of resin-coated resistors, however, the extent of their degradation is too high to put them to practical use. It is considered that the effect of impurities in the resin coating appears sensitively in the moist environment. (auth)

12247 SEPARATION OF NUCLEAR FISSION FRAGMENTS IN ELECTRIC AND MAGNETIC FIELDS. Arifov, U. A.; Belyaev, A. D.; Kogan, V. I.; Pikul, V. P.; Usmandiyarov, A. M. (Inst. of Electornics, Tashkent). Dokl. Akad. Nauk SSSR; 204: No. 3, 586-9(21 Mar 1972). (In Russian).

For the purpose of ascertaining further properties of fission products closer to the moment of fission, a special mass spectrometer, equipped with semiconductor detectors, was constructed which would provide the required electric and magnetic fields for separating the fission fragments. Calibration was based on the two intense α-particle lines in the energy spectrum of ^{238}Pu, which also provided a measure of the resolution. The mass spectrometer successfully separated fission fragments with good resolution about one μs after the act of fission, and yielded data on mass, effective charge, and energy of the fragments. (KSW)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 11776, 11909, and 12510.

12248 (AES–10) SUPPLY OF ENRICHED URANIUM. Martensson, M. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1972. 54p. (In Swedish). Dep. NTIS (U. S. Sales Only).

A general description of the development of uranium enrichment is presented. Special attention is given to developments in Europe and to the efforts to create an independent European enrichment industry. Developments in USA, England, France, and West Germany are reported. An economic comparison is performed between three possible methods of uranium enrichment – gas diffusion, centrifuges, and the separation nozzle process. The costs of investments and of electric power consumption are especially analyzed. (Sweden)

12249 (PG-Inf.-Ser.–25) BIBLIOGRAPHY ON ISOTOPE SEPARATION BY THE GAS CENTRIFUGE. PART 1. BOOKS, REPORTS, JOURNAL ARTICLES, AND CONFERENCE PAPERS. Lowe, G. E. (comp.) (United Kingdom Atomic Energy Authority, Capenhurst (England). Production Group). Apr 1970. 100p. Dep. NTIS (U. S. Sales Only).

Three hundred and six references are presented, with abstracts, on unclassified centrifuge literature from books, theses, reports, journal articles, government publications and a few newspaper articles. The period covered is from 1895 to March 1970. Bibliographies are listed, and also books, some of which are non-technical for background information. The main bibliography is then arranged chronologically under the headings reports, journal articles, and conference papers. There are author and subject indexes and also a report number index which includes the issuing body. (UK)

12250 SENSITIVITY ANALYSIS OF IDEAL CENTRIFUGE CASCADE FOR PRODUCING SLIGHTLY ENRICHED URANIUM. Kawai, T.; Inoue, K.; Motoda, H.; Kobayashi, T.; Kiguchi, T. (Hitachi Ltd., Kawasaki, Japan). Nucl. Sci. Eng.; 50: No. 1, 63-72(Jan 1973).

Characteristics of an ideal cascade are analyzed by two differential equations representing the conservation of UF_6 and $^{235}UF_6$ flow. The controlling variables are identified as the cut and the separation factor of centrifuges and of stages as well as feed flow rate. The controlled variables are flow rate and enrichment of stages, especially of the product and waste. The sensitivity of the controlled variables to the controlling variables is analyzed by linearizing the conservation equations, and analytic expressions are obtained. The change in the separative work of the cascade is a sum of changes in the separative work of the constituent centrifuges. When the flow rate is chosen to optimize the separative work of a single centrifuge, the plant separative work is maximum and stationary at the rated feed flow. It has been demonstrated in a few examples that these simple relations for the ideal cascade are useful for the planning, design, and operation of cascade plants. (auth)

12251 IMPROVEMENTS IN OR RELATING TO THE SEPARATION OF HYDROGEN FROM GASEOUS MIXTURES CONTAINING HYDROGEN. Darling, A. S. (to Johnson, Matthey and Co. Ltd.). British Patent 1,292,025. 11 Oct 1972. Filed 18 Oct 1968.

Reference is made to separation methods employing diffusion through a H_2 permeable membrane, and particularly to suitable membrane materials. The membrane material described comprises an imperforate substrate of Ni, Fe, V, Ta, or Nb, or an alloy thereof, coated on both sides with a discontinuous or porous film of Pd or alloy thereof. Where the coating is discontinuous at least 25%, and preferably 75 to 80%, of the substrate should be coated. The Pd is preferably 99% pure, but if desired Pd/Ag alloys containing 10 to 40% Ag may be used. The coating may be applied by printing techniques, electron deposition or spraying. In tests it was found that H_2 diffusion rates for Fe and Ni substrates were somewhat lower than for Pd alone, but V and Ta foils gave higher diffusion rates than Pd alone. The composite foils are cheaper to manufacture than Pd foils hitherto used, since the Pd coating may be as little as 0.0005 inch in thickness, and they are much stronger. The method of use is also described, including use for the preparation of heavy water by electrolysis or electrolytic migration. (UK)

12252 PRESENT STATUS AND EVALUATION OF THE NOZZLE PROCESS. Mikami, H. (Tokyo Inst. of Tech.). Genshiryoku Kogyo; 18: No. 8, 10-16(Aug 1972). (In Japanese).

Based on the information from Kernforschungszentrum Karlsruhe, the present status of nozzle process for uranium enrichment is reviewed. The fundamentals of the process, its procedure, data available, and economic evaluation of nozzle process plants are reviewed. In this process, UF_6 gas of mixed isotopes is ejected through nozzles to separate ^{235}U by means of a barrier. At Karlsruhe, the nozzle configuration is a combination of tapered nozzle and bent free jet, its assembly being made by dovetailing. The nozzles are arranged around the periphery of a cylindrical body. The enriched fraction is collected outside the cylinder. To increase separation efficiency, light gases such as He, H_2, etc. are mixed with the UF_6; the current data for these gases are given. In the economy of the nozzle process, power consumption per separation element, investment in facility, and also the concentration of the light gaseous additive are involved. Examples of the calculation of the process economy are given, including the effect of the light gas addition, and that for plant actually planned. (Japan)

12253 DEVELOPMENT OF THE CENTRIFUGE METHOD. Kanagawa, A. (Nagoya Univ., Japan). Genshiryoku Kogyo; 18: No. 8, 17-21; 43(Aug 1972). (In Japanese).

In the enrichment of uranium, the employment of either gaseous diffusion, centrifugal separation, or the nozzle process is attracting world interest. Merits of the centrifugal method are in its low consumption of energy and high separation efficiency. Research and development efforts in the past are reviewed, including those in Germany and U.S.S.R.; these are represented by the work of Groth and of Zippe, respectively. Features of the Groth-type centrifuge are employment of rotary shafts both at the top and bottom of a drum, and gas circulation by thermal convection. In the Zippe type, the rotary shaft is only at the bottom. Finally, economic aspects of the centrifugal method for practical plants, compared with that of the gaseous diffusion, are discussed. The number of centrifuge units is exceptionally large. Problems of support of the drum, inlet and outlet of UF_6 gas and its circulation, and other mechanical points are described. (Japan)

12254 URANIUM ENRICHMENT USING ION EXCHANGE. Kakihana, H. (Tokyo Inst. of Tech.). Genshiryoku Kogyo; 18: No. 8, 22-6(Aug 1972). (In Japanese).

Of three general methods of uranium enrichment, e.g., gaseous diffusion, centrifugal separation, and ion exchange, the last has many points of intriguing interest. This is in two aspects, i.e., utilization of so-called quantum effect and economy. Advantage of studies in Japan in this connection is discussed. An attempt was made to classify chemical separation, i.e., the enrichment of uranium. Concerning utilization of ion exchangers, the following two instances are exemplified. In the enrichment of uranium by electrophoresis with ion exchange, deviation from Stokes' theory is used in the latter phase; its merits over other media are indicated. The enrichment apparatus combining the electrophoresis and ion-exchange methods is given as an example. In the enrichment by ion-exchange chromatography, when uranyl is to be used, it is necessary to sever the coupling between uranium and oxygen to have a large quantum effect. (Japan)

12255 METHODS OF URANIUM ENRICHMENT. Kelling, F. E. T. Atoomenergie Haar Toepass.; 14: 297-312(Dec 1972). (In Dutch).

The principles and different methods of isotope enrichment are reviewed, with emphasis on the gascentrifuge. Included is a comparison of three methods competing with each other. (auth) (Netherlands)

12256 METHOD OF CALCULATION FOR A STEP CASCADE WITH SIDE FLOW FOR ENRICHING URANIUM. Yamashita, S. (Sumitomo Atomic Energy Industries, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 9: No. 12, 721-7(Dec 1972).

The step cascade with side flow is defined as a step cascade in which uranium of lower assays than that from the final stage is withdrawn, and in which also, in addition to the major feed, reprocessed spent uranium is introduced as minor feed. A method of calculation is proposed for finding the exact total flow rate of the stream entering the separators in a step cascade with side flow in steady state and without losses of uranium. Using this method of calculation, it is found that the separation factor of diffusers in the new gaseous diffusion plant to be established in the United States is about 1.0022. Moreover, the characteristics are revealed for a step cascade with side flow adopted for a plant treating the estimated amounts of enriched uranium necessary for and uranium discharged from pressurized and boiling water reactors in the nuclear power generating program of Japan in 1985.

Results indicate that the method presented proposes useful means for a detailed design of the plant. (auth)

Isotopic Power Sources

Refer also to abstracts 11876, 11934, and 13551.

12257 (TRW-2617-3) TRANSIT RTG. Final Report. Program Report Number 4. (TRW Systems Group, Redondo Beach, Calif.). 15 Dec 1971. Contract AT(29-2)-2617. 254p. Dep. NTIS.

The overall RTG system and each major component including the thermoelectric converter, the heat source and the supporting structure are described. Nuclear safety considerations are summarized followed by a final section dealing with the ground support equipment necessary to handle and check out the flight RTG prior to launch. (TFD)

12258 TRANSIENT TEMPERATURE DEPENDENCE OF RADIOACTIVE REFERENCE LIGHTS. Lucas, A. C.; Kapsar, B. M. (Harshaw Chemical Co., Solon, OH). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 95-100(Jun 1972).

The 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Scintillating phosphors intimately mixed with long-lived radionuclides are used to construct stable reference lights for many measurement applications. If phosphors having long-lived traps are used in the construction of such lights, the temperature dependence of light emission may be a complicated function of the temperature history of the reference light. The transient temperature dependence was calculated for several traps ranging in depth from 0.5 to 1.5 eV. Experimental data are presented for Harshaw TLD-100, CaF_2:Mn, CaF_2:Dy, ZnS, and NaI(Tl). The calculations and measurements show that phosphors should be chosen which have either very deep traps not likely to produce light at normal operating temperatures or those which have shallow traps likely to equilibrate in a short time. (auth)

12259 ISOTOPE BATTERY WITH HIGH EFFICIENCY. Funkschau; 44: No. 14, 494(1972). (In German).

A brief description of TRISTAN (thermoelectric radioisotope generator for terrestrial applications) with $^{90}SrTiO_3$ heat source is given. (GF)

Radiation Sources

12260 (RD/B/N-2431) ADDITION OF A SECOND ^{60}Co SOURCE TO THE B.N.L. GAMMA IRRADIATION FACILITY. Best, J. V. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct 1972. 17p. Dep. NTIS (U. S. Sales Only).

A second ^{60}Co source has been added to the gamma irradiation facility. The new source has a fixed geometry annular design, providing one central high dose rate position of 42.7 mW/g^{-1} and 8 outer irradiation positions of 9 to 10 mW/g^{-1} with a load of 24 KCi. The new source supplements the existing source by increasing the number of irradiation positions from 8 to 17 and provides a dose rate closer to AGR conditions. When not in use the source is stored, outside the gamma cell, in a lead filled container which also serves as transport flask to enable the source to be taken away for reloading. This arrangement avoids the necessity of handling unshielded sources during the reloading process. The layout of experimental irradiation positions and a typical single-pass graphite corrosion rig is described. (auth)

12261 ^{252}Cf PROGRESS. Californium-252 Prog.; No. 13, 1-61(Oct 1972).

CALIFORNIUM-252—sales of, cost and form for USAEC
—shipping and storage of, design of shielded containers for
—uses of, evaluation of
GAMMA SPECTROMETERS—description for activation analysis using californium-252
MINERALS—exploration and processing of, performance of californium-252 neutron source for
NEUTRON SOURCES—performance of californium-252, for natural resource exploration and processing
—evaluation of californium-252, establishment of demonstration centers for
—evaluation of californium-252, for radiotherapy, oxygen enhancement ratios and RBE
—evaluation of californium-252, for neutron activation analysis and neutron radiography
—evaluation of californium-252, for process control in coal mining industry
—evaluation of small californium-252, for neutron weighing of charges of explosives, propellants, and related hydrogenous materials in munitions
—evaluation of californium-252, for activation analysis and nuclear safeguards
—shipping and storage of californium-252, design of paraffin-filled drum for
SHIELDED CONTAINERS—design for shipping and storage of californium-252 neutron sources (R.C.K.)

12262 FORMATION OF DOSE FIELDS WITH HIGH GRADIENT BORDER ZONES. Vainberg, M. Sh.; Korf, N. N. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol.; 16: No. 11, 59-64(Nov 1971). (In Russian).

A comparison was made of calculated and experimental data on dose field formation during large-field irradiation with the use of protective shielding. In the case of ^{60}Co γ radiation the optimum height of a lead block is 5 to 6 cm. Methods of construction of the isodose pattern using model charts for open fields are described. The latter are based on an allowance for disturbances inserted by shielding blocks in the dose field of the unshielded operating beam. (tr-auth)

12263 DEVICE FOR CENTERING OF FILTERS FORMING THE DOSE FIELD. Devyatykh, Yu. N.; Morozov, A. I.; Mitkevich, D. S. (Moscow Regional Scientific-Research Clinical Inst. Moscow Scientific-Research Rentgeno-Radiological Inst.). Med. Radiol.; 16: No. 10, 68-9(Oct 1971). (In Russian).

A design is described of a universal device for the centering of a direct beam of ionizing radiation for the gamma-emitter (Luch-1) with an irradiation source-surface distance of 50, 60 and 75 cm, which during irradiation permits the use of additional dose field forming devices. (auth)

12264 FORMATION OF DOSE FIELDS OF SPECIAL CONFIGURATION WITH THE AID OF A COLLIMATOR WITH A CONTROLLED WINDOW. Denisenko, O. N.; Kozlov, V. A.; Il'ichev, B. V.; Chilingarov, K. M. (Scientific-Research Inst. of Medical Radiology, Moscow). Med. Radiol.; 16: No. 10, 63-8(Oct 1971). (In Russian).

A method is described for forming dose fields of special configuration (including a wedge-like form) with the aid of a collimator, the plate of which could be moved during irradiation. A brief description of an experimental device and the results derived are given. The principal advantages of this method in comparison with the technique involving the use of different absorbents are discussed. (auth)

Design and Fabrication

Refer also to abstracts 12209 and 12210.

Industrial Uses

Refer also to abstract 12282.

12265 (EURISOTOP-44) TECHNOLOGY OF RADIOINDUCED INHIBITION OF SPROUTING OF POTATOES. Sandret, F. (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). 1971. 70p. (In French). Dep. NTIS (U. S. Sales Only).

Studies on radioinduced inhibition of potato sprouting are discussed under the following headings: goals and programs of technological analyses; results of physical determinations; changes in chemical composition of tubers; and technological and culinary characteristics. It was found that treatment with doses of 10,000 rad gamma or x radiation completely inhibited sprouting. The use of chemical inhibitors was not as satisfactory as radiation. Irradiation did not increase the susceptibility of tubers to bacterial or fungal infections. Inhibition of sprouting obtained by irradiation or chemical treatment prolonged the storage life of the tubers by two to three months. There were no significant differences in biochemical changes between irradiated tubers and those treated with chemical inhibitors. (H.L.W.)

12266 (EURISOTOP-62) IRRADIATION TECHNIQUES IN THE TEXTILE AND POLYMER INDUSTRY. Bibliography, Vol. III. Merkle, R. (comp.) (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). May 1972. 192p. (In several languages). Dep. NTIS (U. S. Sales Only).

A collection of abstracts on problems relating to the use of radiation in the textile industry is presented. Part III includes a collection of abstracts to cover the polymer industry as well, since the textile industry does in fact use numerous polymeric products such as foils, fibres, coatings and impregnants. The enlarged scope of the subject matter is therefore calculated to serve the interests of both textile and plastics specialists. (auth)

12267 GROWTH AND UPTAKE OF NITROGEN BY WHEAT AND RYEGRASS IN FUMIGATED AND IRRADIATED SOIL. Jenkinson, D. S.; Nowakowski, T. Z.; Mitchell, J. D. D. (Rothamsted Experimental Station, Harpenden, Eng.). Plant Soil; 36: No. 1, 149-58(1972).

Wheat and ryegrass were grown in pots containing soil that had either been irradiated, fumigated with methyl bromide, fumigated with formaldehyde, or left untreated. All pots received a basal dressing of potassium, phosphorus, and magnesium; response to nitrogen was tested by applying either 0, 0.177, or 0.354 g nitrogen per pot. Irradiation increased the growth of wheat and ryegrass; uptake of nitrogen was also increased in both crops. The amount of fertilizer nitrogen equivalent to the nitrogen supplied by seeds and soil (the N value) can be calculated from the efficiency of uptake of fertilizer nitrogen and used to allow for the effect on crop growth of the nitrogen released by irradiated soil. With wheat, the increase in growth can be attributed solely to the extra mineral nitrogen released by irradiated soil. However, ryegrass grew a little better than would have been expected if the only effect of irradiation was to increase the release of soil nitrogen. Fumigation with methyl bromide or formaldehyde increased the growth of wheat and ryegrass not given fertilizer nitrogen. However, fumigation with methyl bromide left ionic bromide in the soil, and this depressed the growth of wheat receiving fertilizer nitrogen. Formaldehyde also left residues; these influenced soil metabolism and sometimes depressed the growth of plants given fertilizer nitrogen. (auth)

12268 INVESTIGATION OF THE FLOW-PARAMETERS OF A MULTIFRACTIONAL STOWING MIXTURE BY MEANS OF RADIOACTIVE ISOTOPES. Korbel, K. (Inst. of Nuclear Physics, Krakow). Houille Blanche; 27: No. 5, 427-34(1972).

This study principally concerns the storage of multifractional sand–water mixtures under forced gravity flow in horizontal pipelines. Radiometric methods were applied to measure the mean density of the mixture and the velocities of the flow and its components. The positioning of the measurement devices along the pipeline are described: radiometric density gage; injector for the different granulometric fractions of sand (quartz) in the water these fractions being labeled with ^{24}Na during the washing; electronic equipment of the density gage, duct and probes. The experimental results obtained were used to establish the kinetics of the components of a mixture in the form of a reduced flow/mean mixture density graph. Under certain conditions, these characteristics become universal and an empirical formula for the slip velocity of the solid phase components can be deduced. (France)

12269 EFFECTS OF LOW-DOSE GAMMA RADIATION ON THE STORAGE LIFE OF SATSUMA ORANGES. Kurosaki, T. (Hiroshima Agricultural Coll., Saijo, Japan); Ogata, K. Engei Gakkai Zasshi; 40: No. 1, 85-90(Mar 1971). (In Japanese).

Satsuma oranges were irradiated with $^{60}Co-\gamma$ radiation of 50, 100 and 200 Krad doses at the rate of 1×10^5 rad/hr, and stored at 2° to 17°C. The irradiation above the dose of 100 Krad caused partial browning of the peels, while at the dose of 50 Krad, the browning was not observed. The 50 Krad irradiated fruits stored at the low temperature were favorable in appearance, showing little shrinkage of peel, and had less microbial growth. Rotting of the fruits irradiated at the doses of 100 and 200 Krad was caused by infection of Alternaria citri, but was not observed in the 50 Krad-irradiated fruits and control fruits. Titratable acidity decreased immediately after the irradiation and was more conspicuous with high dose, but slow during storage. Concentrations of citric acid and malic acid were lower in the irradiated fruits than unirradiated ones, and in the irradiated samples, succinic acid was accumulated. Ascorbic acid content of the irradiated fruits decreased with increasing dose. No change was noted in sugar content of the irradiated fruits. (Japan)

LIFE SCIENCES

12270 (JPRS-57517) SPACE BIOLOGY AND MEDICINE, VOL. 6, No. 5, 1972. Translation of Kosm. Biol. Med.; 6: No. 5, 3-90(1972). 150p. NTIS.

A separate abstract was prepared on one section of this report Other sections discuss the selection and training of cosmonauts; evaluation and analysis of accumulated data to facilitate the ongoing transition from orbital to interplanetary flights; research aimed at guaranteeing safety on long flights and reliability of the human component of the man-spaceship system; space psychology and physiology; environmental problems and their control in spacecraft. (CH)

For an abstract of an individual section see: 12331.

Radiation Effects on Biochemicals

Refer also to abstracts 11780, 11836, and 11837.

12271 (BFL-3/1972) LONG-TERM ANIMAL FEEDING STUDY FOR TESTING THE WHOLESOMENESS OF AN IRRADIATED DIET WITH A HIGH CONTENT OF FREE RADICALS. Reichelt, D.; Renner, H. W.; Diehl, J. F. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe (West Germany). Institut fuer Strahlentechnologie). Apr 1972. 132p. (In German). Dep. NTIS (U. S. Sales Only).

A diet containing 35% irradiated milk powder (4.5 Mrad), with a high content of long-lived free radicals, was tested in a 3-year multigeneration feeding study using a total of 716 rats. The following parameters were studied (some not in all generations): growth, food consumption, duration of pregnancy, litter size, litter weight, and weaning ratio, blood picture including hemoglobin and hematocrit, electrophoretic separation of serum protein fractions, total protein, serum enzyme activities (GPT, GOT, AP, SDH), bone marrow smears, urine tests, sleeping time after pentobarbital anaesthesia, teratological and mutagenicity studies, organ weights (heart, liver, kidney, spleen), body weights and gross pathology, histopathology of organ slices (lung, liver, spleen, kidney, adrenals), and of all tumors, measurements of chronaxy. A diet containing 80% irradiated milk-powder (4.5 Mrad) was fed for one year (total of 45 rats). Irradiation caused a considerable decrease in the levels of vitamins A, E, and B_1 in the milk powder. With the exception of differences in body weight after a feeding period of one year, which showed up in some generations and disappeared when the diet was discontinued, no significant differences were observed between groups. When vitamin supplements were given, no differences in body weight were found, even with a diet containing 80% of irradiated milk-powder. The consumption of a diet with a high content of free radicals does not appear to cause biological effects. (auth)

12272 (CONF-721102-3) REPAIR OF RADIATION AND CHEMICAL DAMAGE TO DNA IN HUMAN CELLS. Buhl, S. N. (Tennessee Univ., Oak Ridge (USA). School of Biomedical Sciences, Oak Ridge National Lab., Tenn.). 1972. 30p. Dep. NTIS.

From 12th international symposium on basic biology; Cali, Colombia (27 Nov 1972).

A review of recent literature on repair of radiation and chemical damage to DNA is presented. DNA is susceptible to damage from extracellular sources. Repair of damaged DNA can be divided into prereplication repair, observed in DNA that is present when the insult is given, and postreplication repair, observed in the daughter strands synthesized after the insult. Recovery and repair in human cells have been measured in a number of ways: by a decrease in reproductive death with dose fractionation by unscheduled DNA synthesis, by repair replication, by sedimentation-velocity studies, by a combination of repair replication and sedimentation-velocity studies with photolysis of BrdUrd-sensitized DNA, and by excision of chemical products or photoproducts from DNA. Recovery of human cells from radiation damage was first described by Lockart et al., who noted that fractionated doses resulted in a lower level of reproductive death than did the same amounts of radiation given in single doses. Possible repair of radiation damage to DNA was first detected when unscheduled DNA synthesis was observed after ultraviolet and ionizing irradiation. The types of damage and modes of repair are described. (auth)

12273 INTERACTIONS OF HISTONES WITH DENATURED AND IRRADIATED DNA. A POSSIBLE MECHANISM OF GENOME ACTIVITY REGULATION IN EUCARYOTIC CELLS. Umanskii, S. R.; Korol, B. A.; Tokarskaya, V. I. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 2, 481-4(11 Jul 1972). (In Russian).

DNA and histones were separated from the thymus of rats by standard procedures. A portion of the DNA was denatured in tris-HCl buffer; a portion of DNA in this same buffer was irradiated with gamma rays from a ^{137}Cs source. Precipitation curves were determined on: native and denatured DNA by histones, irradiated DNA by histones before and after thermal denaturation. Maximum precipitation of native DNA was achieved with a histone/DNA ratio of 2; for denatured DNA the required ratio was 3.5. For irradiated DNA, larger doses of radiation increased this ratio (from about 2 to 3.5). (K.S.W.)

12274 KINETICS OF ENDOGENOUS SH-GROUPS IN PRIMARY PROCESSES OF RADIATION DAMAGE. Petrosyan, E. P.; Korinteli, V. I.; Yarmonenko, S. P. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol.; 17: No. 7, 29-32(Jul 1972). (In Russian).

Determination of endogenous SH group changes in the homogenate of rat spleen immediately after irradiation was carried out by means of a specially designed semiautomatic set. It appeared that irradiation of the homogenate was followed by a pronounced diminution of the SH group level reaching its maximum (by 20%) at a dose rate of 500 rads and which does not practically rise with further increase of the absorbed dose (to 2,500 rads). After irradiation, there occurs intensive regeneration of SH groups, attaining its initial level in 20 min. (auth)

12275 INACTIVATION OF RIBONUCLEASE A IN AQUEOUS SOLUTION BY IONIZING RADIATION. Rokushika, S. (Kyoto Univ.); Murakami, F.; Senda, T.; Hatano, H. J. Radiat. Res.; 13: No. 4, 221-9(Dec 1972).

Ribonuclease A was gamma-irradiated in a dilute aqueous solution. The G^0 value of inactivation of the enzyme was 0.45. When the enzyme lost its enzymatic activity significantly, some physicochemical or chemical properties were found to be altered, while others were not. Unaltered properties were type of amino acid terminals, optimum pH, and pH-enzyme activity curves. Properties affected by irradiation were a destruction of some amino acid residues, an alteration of electrophoretic mobility, and an increased reactivity to diazo-1-H-tetrazole. The extents of alteration of the latter two properties were dependent upon the radiation dose. These results suggest that the ionizing radiations induce a local conformational change in the enzyme molecule and that this may play an important role in the inactivation of the enzymatic activity of ribonuclease A. (auth)

Radiation Effects on Cells

Refer also to abstracts 11789 and 12303.

12276 (BNL-17292) CELLULAR RADIOBIOLOGY AND PARTICLE RADIOTHERAPY: PRINCIPLES, PRESUMPTIONS, AND PITFALLS. Elkind, M. M. (Medical Research Council, London (England). Experimental Radiopathology Research Unit). 1972. 11p. (CONF-721045-2). Dep. NTIS.

From Conference on particle accelerators in radiation therapy; Los Alamos, NM (2 Oct 1972).

To develop an overview of the radiobiology of cells important in charged particle radiation therapy, one must start with low linear energy transfer (LET) radiations (e.g. x, γ rays, and energetic electrons). This is because new treatment modes are ordinarily compared to the results obtained with low LET radiations and considerably more biological information is available relative to low versus high LET beams. The major radiobiological features of the way cultured mammalian cells respond to ionizing radiations are reviewed starting with low LET effects. Data on the effects of oxygen and repair of sublethal damage on survival time are reviewed. The presumptions upon which improved therapy with high LET (particle) radiations is based are discussed and areas where caution is needed and new data required to avoid those possible pitfalls relatable to cellular responses are pointed out. (CH)

12277 (COO-3243-1, pp 225-303) RADIOBIOLOGY. 1 Jul 1972.

In Annual report on research project.

Progress is reported on the following research projects: the oxygen enhancement ratio for ^{252}Cf measured with mammalian cells in culture; radiobiological studies with monoenergetic neutrons; OER and RBE measurements with the 3.9 GeV nitrogen ion

beam using Vicia seedlings as a test system; OER and RBE measurements with the 3.9 GeV nitrogen ion beam using cultured mammalian cells; inhibition of exponentially growing cells by conditioned medium extracted from cells in plateau phase; the relationship of intracellular cyclic AMP to radiosensitivity; and in vitro cell transformation by ionizing radiation. (HLW)

12278 (UCSF-10-P-2-182) SURVIVAL OF CLONOGENIC CELLS FROM A MURINE SOLID TUMOR TREATED IN VIVO WITH RADIATION AND CHEMOTHERAPEUTIC AGENTS. Wharam, M. D.; Phillips, T. L.; Kane, Lawrence; Utley, J. F. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). 1972. 20p. Dep. NTIS.

The transplantable EMT6 murine solid tumor will clone in tissue culture with a plating efficiency of 25%, permitting direct quantitative assessment of the effect of various cytotoxic agents administered in vivo. This system was used to study the combined effect of gamma radiation and chemotherapy. A dose of cyclophosphamide, actinomycin D, BCNU, and bleomycin A2, selected to yield a 10% survival fraction when given singly, was administered two hours before graded single doses of whole-body γ radiation. The results were compared to a radiation dose-response curve. Actinomycin D, bleomycin, and BCNU modified the shoulder region of the radiation dose-response curve and thereafter actinomycin D and bleomycin became gradually less than additive in the hypoxic region of the curve, whereas BCNU remained additive. Cyclophosphamide was simply additive throughout the entire dose-response curve. Synergism was apparent with radiation doses below 600 rads for each drug except cyclophosphamide. (auth)

12279 SYNDROME-STRESS AT THE CELLULAR LEVEL AND ITS ROLE IN THE REACTION OF CELLS TO RADIATION. Kalendo, G. S. (Inst. of Experimental and Clinical Oncology, Moscow). Usp. Sovrem. Biol.; 73: No. 1, 59-80 (1972). (In Russian).

The non-specificity of the initial reactions of cells to different destructive agents suggests that in response to ionizing radiation there also occurs an instantaneous mobilization of this nonspecific protection system at the cellular level. Data on the high stability of the fixed regulating systems under unfavorable conditions are adduced which assure an expedient response to the disturbing activity. The expediency of initial cell reactions in response to radiation confirmed the similarity with effects observed during early stages of the effects of the majority of artificial radioprotective agents. The radioprotective processes are controlled by homeostatic mechanisms. (tr-auth)

12280 NITROFURANS AS RADIOSENSITIZERS OF HYPOXIC MAMMALIAN CELLS. Chapman, J. D.; Reuvers, A. P.; Borsa, J.; Petkau, A.; McCalla, D. R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Cancer Res.; 32: No. 12, 2616-24(Dec 1972).

Our studies showed that various nitrofuran derivatives have excellent radiosensitizing properties in hypoxic Chinese hamster cells at concentrations at which there is no effect on plating efficiency. The radiosensitizing effect is primarily a dose-modifying effect, with nitrofurantoin, nitrofurazone, and nifuroxime (each at 500 μM) in complete medium giving enhancement ratios of 1.65, 2.0, and 2,2, respectively. In parallel studies, the radiosensitizing effect of molecular oxygen (air-saturated conditions) was found to be dose modifying, with an enhancement ratio of about 2.9. Selective radiosensitization in hypoxia was demonstrated in proliferating populations of cells in every phase of the cell cycle, as well as in nonproliferating populations that were contact inhibited at the time of irradiation. In all cell populations tested, these compounds did not alter radiosensitivity in air-saturated conditions. The permeability of phospholipid membranes to nitrofurazone in 0.1 M NaCl was measured, and a permeability constant (K) of 1.5 ($\pm$0.7) $\times$ 10^{-5} cm/sec obtained. No diffusion time lag was observed. In the presence of 0.1 M NaCl and 0.5 mM $MgCl_2$, the permeability constant was increased to 2.5 ($\pm$0.4) $\times$ 10^{-5} cm/sec, and a diffusion lag time of 12 $\pm$ 3 min was obtained. Comparison of this constant with permeability constants for other molecules suggests that the phospholipid membrane presents no great barrier to the penetration of this compound. Hypoxia is shown to enhance the rate of radiation-induced binding of the label from nitrofurazone-^{14}C to bovine serum albumin, DNA, polynucleotides, and Chinese hamster cells. Mechanisms of radiosensitization are discussed in relation to the observed binding and the antibacterial mode of action of the nitrofurans. The potential application of this class of compounds in the radiotherapy of tumors in which hypoxia is suspected is discussed in relation to their known pharmacological properties and current clinical usage. (auth)

12281 PHOTOREACTIVATION OF ULTRAVIOLET-INDUCED CHROMOSOMAL ABERRATIONS. Griggs, H. G.; Bender, M. A. (Vanderbilt Univ., Nashville). Science; 179: No. 4068, 86-8 (5 Jan 1973).

Ultraviolet radiation induces only chromatid-type aberrations in synchronized G_1 V-79 Chinese hamster and A8W243 Xenopus tissue culture cells. Posttreatment with white light prevents expression of most potential aberrations in the A8 toad cell, which possesses a photoreactivation enzyme. We conclude that the major ultraviolet-induced DNA lesion leading to chromosomal aberrations is the pyrimidine dimer. (auth)

Radiation Effects on Microorganisms

12282 (EURISOTOP-70) ECONOMIC AND TECHNOLOGICAL STUDY OF THE IRRADIATION OF SHRIMPS (CRANGON VULGARIS FABR.). Hovart, P.; Schietecatte, W.; Vyncke, W. (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). Sep 1972. 172p. Dep. NTIS (U. S. Sales Only).

The preservation and marketing of shrimp in the European Economic Community including Belgium, France, the Netherlands, and West Germany are discussed in detail. Discussion of the shrimp preservation technology includes the following topics: the perishability of shrimp; chemical and physical preservation processes including chemical preservation, deep-freezing, lyophilization, and heat treatment; the prolongation of storage life by irradiation; and economic aspects of irradiation. It is concluded from the discussions that irradiation does not rule out the other methods of preservation, but does present worth-while aspects. (E.R.B.)

12283 (IAEA-R-620-F) PILOT-PLANT STUDIES ON THE RADICIDATION OF PELLETIZED FISHMEAL. Final Report for the period 1 April 1968-31 March 1970. van Kooij, J. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 5p. INIS.

International trade in animal feed products has seriously increased the risk of outbreaks of food poisoning in human beings and animals. Decontamination of feeds by means of pelletization using steam was investigated as a method of controlling harmful organisms in these products. However, this technique does not preclude recontamination after processing the feed pellets. A combination of pelletization followed by a low dose irradiation of feed may be a promising approach to the manufacture of Salmonella-free animal feeds. Investigations were undertaken to study the level of Salmonella contamination of imported feed pellets and to determine the radicidation dose necessary for the elimination of these organisms in pelleted fish meal. Fish meal pellets were gamma-irradiated at doses of 150, 300, and 600 Krad, respectively. Bacteriological studies of non-irradiated and irradiated samples included determination of the most probable number of bacteria belonging to the family Enterobacteriaceae. Besides, samples were also tested for the presence of Salmonella. It was found that irradiation at the various dose levels administered resulted in a reduction of bacterial counts of the Enterobacteriaceae family. An irradiation dose of 200 Krad reduced the count by a factor of 10, while decontaminative effects of a dose of 350 Krad provoked more harmful effects. A dose of 600 Krad was found to rid the fish meal pellets from bacteria of the Enterobacteriaceae family. It was also found that Salmonella radicidation of fish meal pellets was invoked by gamma-irradiation at the doses studied. (INIS)

12284 (IAEA-R-661-F) STUDIES ON EFFECTS OF RADIATION ON SNAKE VENOMS WITH SPECIAL ASPECTS ON THEIR STERILIZATION. Final Report for the Period 1 September 1968-30 November 1971. Purananda, C. (International Atomic Energy Agency, Vienna (Austria)). Jan 1972. 13p. INIS.

The effects of ^{60}Co irradiation on Russell's viper venom and Cobra venom antigenicity and toxicity were assayed. Initial trials with mice and sheep as the antibody producing animals were unsuccessful. Results utilizing the rabbit for antibody production were successful and the following results obtained. Immunodiffusion and immunoelectrophoresis assays show that irradiation alters the antigenicity of both venoms as indicated by banding patterns and number of bands. Toxicity determinations indicate that irradiation detoxifies both venoms progressively until complete detoxification is achieved at 4.0 Mrads. Antigenicity was assayed by immunizing rabbits with venoms irradiated at various doses and testing the resulting antiserum by neutralization techniques. The results indicate that detoxified (4.0 Mrad) Russell's viper venom retains about 75% of the antigenic powers of untreated venom. Although too few samples were available to give statistically accurate results, the same value for detoxified cobra venom appears to be appreciably lower at about 40%. It is concluded that, at least in some animals, the use of radiation detoxified venom may be a useful means of immunization or antibody production. For radiosterilization purposes it was found that 0.5 Mrad of irradiation provided a venom free of microbial contaminants. (INIS)

12285 ULTRASTRUCTURAL CHARACTERIZATION OF HAMSTER CELLS TRANSFORMED FOLLOWING EXPOSURE TO ULTRAVIOLET-IRRADIATED HERPES SIMPLEX VIRUS TYPE 2. Glaser, R.; Duff, R. G.; Rapp, F. (Pennsylvania State Univ., Hershey). Cancer Res.; 32: No. 12, 2803-6(Dec 1972).

Herpes simplex virus type 2 rendered defective by ultraviolet irradiation transformed hamster embryo fibroblasts in vitro. When the transformed cells were inoculated into newborn hamsters, solid tumors developed and cell cultures were established. The virus-transformed cells, the solid tumors, and the tumor cell cultures were examined by electron microscopy. The transformed cultures and tumors contained cells with nuclei in which the chromatin had become condensed and marginated; this picture resembled the cytopathology induced during lytic infection by herpes simplex virus. These abnormalities were observed in some cell culture lines established from the tumors. Virus-like particles, similar in size and morphology to nonenveloped herpesvirus, were found in the nuclei of a small number of degenerating cells in some of the specimens examined. (auth)

12286 MICROBIOLOGICAL PROBLEMS IN FOOD IRRADIATION AND RADIOSENSITIZATION. Faizur-Rahman, A. T. M.; Siddiqui, A. K.; Amin, M. R. (Atomic Energy Centre, Dacca, Pakistan). Nucleus (Karachi); 9: No. 1-2, 47-54(1972).

Different food spoilage microorganisms including the viruses have varying degrees of radioresistance, some of them requiring doses in the range of megarad for a ten log reduction in population. This high-dose requirement for the preservation of some foods causes undesirable changes, losses in the nutritive value and organoleptic qualities of these food items. Efforts were made to reduce the radiation dose requirement by sensitizing the cells to thermal and chemical treatments. These methods of attaining radiosensitization of microorganisms and their possible application to actual food processing were discussed in the review. The problem of the acquiring of radioresistance by microorganisms on successive irradiation and its practical significance was also discussed. (auth)

12287 EFFECTS OF RADIATION ON FUNGI. PART I. IONIZING RADIATIONS. Malik, M. A.; Mohyuddin, M.; Osman, N. (Radiation Genetics Inst., Lyallpur, Pakistan). Nucleus (Karachi); 9: No. 1-2, 57-60(1972).

Fungi are very important agents of spoilage for a large number of foods and other consumer materials. Ionizing radiations have proved to be an effective fungicidal agent and are being used to control mould growth. Ionizing radiations cause a number of changes in fungi, and in the present paper these effects are reviewed. Besides food spoilage fungi, plant pathogenic fungi have also been included. (auth)

12288 QUANTITATIVE ANALYSIS OF NEGATIVE LIQUID HOLDING IN SOME UV SENSITIVE MUTANTS OF YEAST. Parry, J. M. (University Coll., Swansea, Wales). Mol. Gen. Genet.; 118: No. 1, 33-43(1972).

Negative liquid holding, the reduction in cell viability produced by post uv holding treatment in saline, is shown by a number of uv-sensitive mutants of yeast. This process was studied in two such mutants of yeast and the decline was shown to be independent of the frequency of pyrimidine dimers and in the case of mutant E9 was independent of the age of treated culture. The data indicates that negative liquid holding is the result of the reduction in the activity of an enzyme system involved in the repair of non-photoreactivable uv induced lesions. (auth)

12289 EFFECT OF A HISTIDINE OPERATOR-CONSTITUTIVE MUTATION ON UV-INDUCED MUTABILITY WITHIN THE HISTIDINE OPERON OF SALMONELLA TYPHIMURIUM. Savic, D. J.; Kanazir, D. T. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Mol. Gen. Genet.; 118: No. 1, 45-50(1972).

The presence of the histidine operator-constitutive mutation his01242 increases uv-induced mutability within the histidine operon of Salmonella typhimurium. The rate of reversion of hisC and hisF ochre and frameshift mutants is increased 5- to 8-fold when these mutations are coupled with his01242 that causes 15-fold derepression of the operon. The effect does not extend to the whole chromosome since the rate of uv-induced mutability at the unlinked streptomycin locus is the same in the strains carrying $his0^+$ or his01242 alleles. The same phenomenon was observed in Hcr^- strains. (auth)

12290 MUTATOR PROPERTY OF uvr502 MUTATION AFFECTING UV SENSITIVITY OF ESCHERICHIA COLI. Smirnov, G. B.; Filkova, E. V.; Skavornskaya, A. G. (Inst. for Epidemiology and Microbiology, Moscow). Mol. Gen. Genet.; 118: No. 1, 51-6(1972).

The frequency of direct and reverse mutations at several chromosomal loci increased in uv sensitive uvr502 strains of Escherichia coli. Both uv sensitivity and mutator (Mut^-) phenotype are due to the single uvr502 mutation. In uvr^+/uvr502 merodiploid the Mut^- phenotype is recessive. (auth)

12291 HOST- AND PHAGE-MEDIATED REPAIR OF RADIATION DAMAGE IN BACTERIOPHAGE T4. Wallace, S. S.; Melamede, R. J. (City Univ. of New York, Bronx). J. Virol.; 10: No. 6, 1159-69(Dec 1972).

Bacteriophage T4+ exhibits increased uv sensitivity on derivatives of Escherichia coli K12 or B lacking deoxyribonucleic acid (DNA) polymerase I. However, the sensitivity of T4v is not affected by the absence of host DNA polymerase. T4x and T4y also show increased sensitivity on DNA polymerase-deficient strains, but to a lesser extent than observed with wild-type T4. When T4x or T4y, but not T4+, is plated on a double mutant lacking both DNA polymerase and the uvrA gene product, a partial suppression of the polymerase effect is observed. Host ligase appears to be able to suppress to some extent the T4y phenotype but has no effect on wild-type T4 or other T4 mutants. T4xv incubated in E. coli B or B_{s-1} in the presence of chloramphenicol (50 μg/ml) shows increased resistance over directly plated irradiated phage. Increased survival under the same conditions was not observed with T4+ or other T4 mutants. The repair of x-ray-damaged T4 was investigated by examining survival curves of T4+, T4x, T4y, T4ts43, and T4ts30. The repair processes were further defined by observing the effects of plating irradiated phage on various hosts including strains lacking DNA polymerase I or polynucleotide ligase. Two classes of effects were observed. Firstly, the x and y gene products seem to be involved in a repair system utilizing host ligase. Secondly, in the absence of host DNA polymerase, phage sensitivity is increased in an unknown manner which is enhanced by the presence of host uvrA gene product. (auth)

Radiation Effects on Plants

Refer also to abstracts 12267, 12277, 12303, 12304, and 12330.

12292 (COO-2085-3) EFFECTS OF GAMMA RADIATION ON LICHENS AND LICHEN-FORMING FUNGI AND ALGAE. Progress Report, December 1, 1971-December 15, 1972. Erbisch, F. H. (Michigan Technological Univ., Houghton). 1972. Contract AT(11-1)-2085. 12p. Dep. NTIS.

External and internal observations of the lichens in the Enterprise Radiation Forest tend to indicate that little damage has occurred to lichen thalli as close as 4M to the ^{137}Cs γ source. The effects of γ radiation on the lichen acids of Cladonia sylvatica were studied. It was found that: C. sylvatica contains more kinds of acids than reported in the literature; the concentration of these acids varies from late winter (many kinds) to early fall (few kinds); and some of these acids disappeared when the thalli were irradiated. It is theorized that these acids may protect the thalli from irradiation by serving as electron donors for those biologically important molecules which have electrons removed by the radiation. The survival of the isolated C. sylvatica algal symbiont was found to be much less than when the lichen is intact. The LD_{100} for the isolated fungus was 100 krad, while the associated algae survived doses of 1,000 krad. (auth)

12293 (COO-2085-4) LICHENS OF THE ENTERPRISE RADIATION FOREST. Erbisch, F. H. (Michigan Technological Univ., Houghton). 1972. Contract AT(11-1)-2085. 21p. Dep. NTIS.

The effects of both environmental change and γ radiation on lichen thalli in their native habitat is questionable. The effects, macro- and microscopically, of these two factors on lichen thalli at the Enterprise Radiation Forest will be studied. Measurements and observations were made, prior to irradiation, of thallus growth, configuration, and coloration; of substrate temperature; of thallus internal structure; and of transplanted thalli, in order to compare with the thalli after the radiation treatment. Results are reported from laboratory studies on the effects of acute and chronic irradiation at various doses on the morphology of Cladonia sylvatica and Cladonia verticillata that showed that lichens are highly resistant to γ radiation. (CH)

12294 (COO-2085-5) EFFECTS OF GAMMA RADIATION ON LICHEN ACIDS. Sartorelli, C. (Michigan Technological Univ., Houghton). 1972. Contract AT(11-1)-2085. 41p. Dep. NTIS. Thesis.

The effects of acute γ radiation on lichen acids produced by Cladonia sylvatica were examined, and the possible protective properties of these acids are theorized. It was shown by thin layer chromatographic, color, and crystallization tests that there were noticeable differences between the kinds of acids detected in the control (nonirradiated) lichens and the irradiated lichens. Atranorin, psoromic, and an unidentified acid become undetectable

after the lichen was irradiated with 10^5 rad. Other acids such as squamatic were found less consistently after the lichens were irradiated. The results suggested that the lichen acids could be responsible for the lichens' high resistance to γ radiation by possibly acting as an electron donor, a reducing agent. The study also indicated that the kinds of acids present in Cladonia sylvatica are more numerous than had previously been reported and that the lichen does not contain the same amounts of each acid throughout the year. (auth)

12295 (ORO-2066-16) GAMMA AND FAST NEUTRON SENSITIVITY OF TREE SEED AND SEEDLINGS. Final Report. Heaslip, M. B. (Morehead State Univ., Ky.). 1972. Contract AT(40-1)-2066. 49p. Dep. NTIS.

The γ sensitivity of seeds of 18 species of forest trees growing in Kentucky showed great variability with species and even within a given genus. The effects of acute γ irradiation of the seeds included: delayed or suppressed germination; inhibition of cotyledon growth resulting in early death; morphological changes in the first true leaves; and an inhibitory effect on the growth of seedlings. The effects of dormancy and water content on the γ and fast neutron radiosensitivity of some seeds were determined. Seedlings of Juglans nigra, Fraxinus americana, and Quercus alba irradiated while dormant or physiologically active were transplanted in a secondary forest. The variations in survival and growth rate observed are considered evidence that a γ irradiated ecosystem inhabited by these three species would change as a result of differences in species radiosensitivity. (CH)

12296 PROGRESS IN THE APPLICATION OF NUCLEAR METHODS IN INCREASING PRODUCTION OF RICE, SOYBEAN, AND COCONUT IN THE PHILIPPINES. Santos, I. S. (Philippine Atomic Research Center, Quezon City). Sci. Rev. (Manila); 12: No. 1, 19-26(1972).

A review is presented of crop improvement research in the Philippines utilizing nuclear methods. Exposure of rice seeds to ^{60}Co gamma radiation resulted in mutations for improved grain type and eating quality, improved resistance to rice blast disease, and improved grain yield potential. Following exposure of soybean seeds to thermal neutrons the plants showed improved grain yield and other agricultural qualities. Studies on the effects of fertilizers on coconuts were conducted using ^{32}P and other radioisotopes as tracers. (H.L.W.)

12297 COMPARATIVE STUDY OF THE EFFECTS OF IONIZING RADIATION AND CHEMICAL MUTAGENS ON THE COTTON PLANT. Atakuziev, S. (Inst. of General Genetics, Moscow). Dokl. Akad. Nauk Uzb. SSR; No. 5, 50-1(1971). (In Russian).

Seeds of the cotton plant were subjected to different treatments: thermal shock, irradiation with doses of γ radiation of 10, 40, and 60 kR, and exposure to the chemical mutagens ethylnitrosourea and ethyl methanesulfate, in a comparative study of the effects of each type of treatment. Germination of the seed was improved by the thermal shock, was reduced by the increasing radiation doses, and was not affected by the chemical mutagens. (K.S.W.)

12298 CHLOROPHYLL MUTATION YIELDS BY ETHYL METHANESULFONATE, GAMMA RAYS, AND FAST NEUTRONS IN RICE. Karunakaran, K.; Kiss, I. S. (Research Inst. for Irragation and Rice Cultivation, Szarvas, Hungary). Riso; 19: No. 4, 287-92(Dec 1970).

Results of studies on mutagenic effectiveness and efficiency of ethyl methanesulfonate, gamma rays, and fast neutrons in the Hungarian rice variety Dunghan Shali are presented and discussed. Comparison is also made between the dry-back and wet variants of EMS treatment. Data based on about 250 M_1 spikes (main earheads representing 250 M_1 plants) and more than 10,000 M_2 seedlings under each treatment allowed the following conclusions: The EMS treatment regime employed yielded 2 to 3 times higher chlorophyll mutation frequency than the gamma rays and fast neutrons. Both higher mutation frequency and larger mutated sectors on the M_1 panicles appear to be achievable at the same time by proper treatment schedules of chemical mutagens like EMS. Possibility of attaining higher mutation frequencies with reduced biological damage in the M_1 is indicated by following EMS treatment regime consisting of long pre-soaking, brief treatment with high concentration, and sufficiently long post-washing. Drying back and storage of EMS treated rice seeds without any loss in the mutagenic effectiveness and efficiency is proved to be possible. Further studies with more varieties, mutagens, and slightly shorter pre-soaking times appear necessary to perfect the dry-back technique in rice. (auth)

12299 INFLUENCE OF GAMMA RADIATION ON THE FORMATION OF OVULES OF THE COTTON PLANT WITH SUPPLEMENTARY POLLEN TUBES. Kalyagina, L. G. (Inst. of Experimental Plant Biology, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 11, 56-7(1971). (In Russian).

Dry seeds of cotton were irradiated with γ rays at doses of 3, 10, and 20 kR. The occurrence of ovules with supplementary pollen tubes was noted in irradiated specimens, and it was concluded that the action of gamma radiation increased the number of ovules with additional pollen tubes as compared with the controls. (KSW)

12300 HIGH YIELDING RADIATION INDUCED MUTANTS OF ALLIUM CEPA L. CV. RED NASIK. Vasti, S. M.; Siddiqui, S. H.; Mujeeb, K. A.; Mustafa, G. (Atomic Energy Agricultural Research Centre, Tandojam, Pakistan). Nucleus (Karachi); 9: No. 1-2, 55-6(1972).

Pure dry seeds of Allium cepa L. cv. Red Nasik were given gamma radiation dosages of 1, 2, 3, 5, and 8 kR from a 13,000 Ci ^{60}Co source. Two mutants (M-8 and M-5) were isolated and tested separately for yield potentials in replicated trials for 4 yr. Both mutants significantly out-yielded the control for the first 3 yr. In the fourth year only M-8 differed significantly (0.05), and appears to be the improved cultivar. The yield potential of M-5 needs to be evaluated further. (auth)

12301 EFFECT OF X RAYS, MOLYBDENUM, AND THEIR COMBINED USE ON THE RADICLES AND YIELD OF HARICOT BEAN. Tsereteli, Ts. G. Soobshch. Akad. Nauk. Gruz. SSR; 68: No. 3, 675-6(Dec 1972). (In Georgian).

Presowing treatment of the seeds of haricot bean (Tsanava-3 and Saparke-75) with molybdenum and x-rays has an effect on the radicles. The data obtained indicate that the energy of seed germination, radicle growth and yield increase markedly as a result of simultaneous treatment of the seeds with molybdenum and x-rays. (auth)

12302 RADIOPROTECTIVE EFFECTIVENESS OF LUVATRENE ON THE X-RAY INDUCED CHROMOSOME BREAKAGE-REUNION PROCESS IN VICIA FABA. Imreh, St.; Uray, Z.; Holan, T.; Lazanyi, A. (Cancer Institut, Cluj). Stud. Biophys.; 29: 205-10(1971).

The action of Luvatrene (LU, psychotropic radioprotective substance) on the chromosome breakage-reunion process in Vicia faba was investigated. It was proved that treatment with LU reduces the frequency of anaphase aberrations in cells irradiated in G_2, S, and to a lesser extent in G_1. The BR index shows a relative increase in the reunion ability of the broken chromatids after LU treatment. The mitotic index shows that this radioprotective action of LU is real and not due to a shift in cell population. (auth)

Radiation Effects on Animals

12303 (COO-3243-1) ANNUAL REPORT ON RESEARCH PROJECT. (Columbia Univ., New York. Radiological Research Lab.). 1 Jul 1972. Contract AT(11-1)-3243. 303p. Dep. NTIS.

Separate abstracts were prepared on three sections of this report. (CH)

For abstracts of individual sections see: 12277, 12304, and 13797.

12304 (COO-3243-1, pp 120-224) BIOPHYSICS. 1 Jul 1972. In Annual report on research project.

Progress is reported on the following research projects: analytical representation of dose effect curves; a method to determine RBE as a function of dose; theory of dual radiation action; theoretical treatment of the dose-rate problem; genetic effects of ionizing radiation on Drosophila melanogaster; and radiobiological studies using the Tradescantia stamen hair. (HLW)

Man

Refer also to abstracts 11967, 11968, 12272, 12276, and 13822.

12305 (AD-743482) COMPARATIVE EVALUATION OF EXPOSURE DISTRIBUTIONS FOR AIR TRAVELERS AND RADIATION WORKERS. Schaefer, H. J. (Naval Aerospace Medical Research Lab., Pensacola, Fla.). 25 Feb 1972. Contract DOT-FA-SS-71-10. 14p. (NAMRL-1159). NTIS.

Radiation workers contribute 0.48 millirem/year per capita of the total radiation dose of the U. S. population. Air travelers exposed to increased environmental radiation levels at altitude contribute 0.54 millirem/year. However, the two respective distributions differ greatly in all other parameters; namely, number of individuals involved, magnitude and spread of individual exposure, and skewness. While the distribution for radiation workers centers heavily on near-zero exposures and reaches out to large excursions in rare cases of accidents, the one for air travelers shows a narrow spread, excludes excursions completely, and does not constitute an additional radiation risk. (auth)

12306 (BNL-17253) RADIOSENSITIVITY OF LYMPHOCYTES. Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). 1972. 19p. (CONF-720956-1). Dep. NTIS.

From Conference on radiosensitivity; Freiburg, Germany (25 Sep 1972).

A review is presented of various aspects of sensitivity of lymphocytes to radiation. Some topics discussed are: historical background; origin and life span of lymphocytes; atrophy of lymphatic tissue following exposure to local and whole-body irradiation; the influence of radiation on the uptake of tritiated thymidine into lymphocytes; radiosensitivity of the immune response; the direct measurement of x-radiosensitivity of lymphatic cells; and the radioresistance of antibody production by stimulated lymphocytic cells. (32 references). (HLW)

12307 (BNL-17418) NOTE ON RADIOTHERAPEUTIC USE OF PARTICLE ACCELERATOR METHODS TO DETERMINE THE STOPPING REGION. Lee, Y. Y. (Brookhaven National Lab., Upton, N. Y.). 26 Oct 1972. 10p. Dep. NTIS.

Various methods to determine the stopping region for hadron beams are discussed. A new method using antiproton beams is proposed. (1 figure, 1 table). (auth)

12308 (CONF-721204-2) ESTIMATES OF DOSE FROM ^{133}Xe TO INFANTS AND CHILDREN FOR IMMERSION IN AN INFINITE CLOUD AND FOR MEDICAL USES. Hilyer, M. J.; Snyder, W. S. (Oak Ridge National Lab., Tenn.). 1972. Contract W-7405-eng-26. 16p. Dep. NTIS.

From 7th midyear topical symposium on health physics in the healing arts; San Juan, PR (11 Dec 1972).

Estimates are presented of the β radiation dose to infants and children in comparison with that to adults submersed in an infinite cloud of ^{133}Xe or following inhalation of a tracer dose of ^{133}Xe during diagnostic medical studies. It is pointed out that the increase in nuclear power production presents the possibility of exposure of the population to ^{133}Xe released to the atmosphere. Estimates of the International Commission on Radiological Protection on the maximum permissible radiation dose from submersion in a large cloud of ^{133}Xe are based on calculations for adults. Data are reviewed from in vivo and in vitro studies that show that when an individual is immersed in an infinite cloud of ^{133}Xe the tissues absorb xenon until the content of body fluids is in equilibrium with that of the atmosphere, and that the solubility coefficient in tissues with a high fat content is 10 to 20 times higher than for tissues with a low fat content. Based on data on the content of adipose tissue in the human body as a function of age, it was concluded that a 10-year old child immersed in a ^{133}Xe cloud might receive a slightly higher radiation dose than at any other age below 20. Between ages 10 to 20 years there might be a sex difference due to larger amounts of fats in females. When a tracer dose of ^{133}Xe is administered by inhalation of a labeled gas for measurements of lung ventilation, a newborn infant receives a total radiation dose per μCi inhaled that is approximately 10 times higher than that of an adult, since the number of breaths per minute and volume per breath in relation to body weight is greater for infants and decreases as a function of age. (CH)

12309 EFFECT OF ^{60}Co RADIATION THERAPY ON THE PLASMA LEVELS OF CORTISOL AND CORTICOSTERONE IN HUMANS. Painter, K.; Shaw, S. M.; Russell, H. T. (Purdue Univ., Lafayette, IN). Radiochem. Radioanal. Lett.; 12: No. 2-3, 145-52(29 Nov 1972).

Cobalt-60 γ radiation therapy of human cancer patients caused a depression in plasma cortisol and corticosterone levels. During the third week of treatment, cortisol levels increased above initial levels and remained elevated, while corticosterone levels appeared to rise gradually back to initial levels during the fourth week of treatment. (auth)

12310 REMOTE RESULTS IN INTERSTITIAL GAMMA-THERAPY OF SKIN ORBITAL CANCER. Volodina, G. I.; Ismagilova, M. I.; Grechishkina, I. A. (Kazan Inst. of Advanced Medicine). Med. Radiol.; 17: No. 7, 3-6(Jul 1972). (In Russian).

Interstitial gamma therapy of skin orbital cancer has been carried out in 877 patients. Remote results were studied in 386 (from 2 to 24 yr). The optimal dose in interstitial therapy is 6,000 to 7,000 rads with the dose rate of 60 to 80 rads per hr. Complete cure was obtained in 98.8% of patients with the first and second stages of the disease and in 75% of the third stages. Relapses were revealed in 3.6% of patients. Cataracts were found in 13.5% (the absorbed dose on the lens was 1,500 to 2,100 rads). Radiation changes of the cranial bones were diagnosed in only 2% of the cases. The intestinal gamma-therapy technique should be closely observed. (auth)

12311 IMPORTANCE OF IODINE METABOLISM CONDITIONS IN DEVELOPMENT OF GENERAL RADIATION REACTION. Palinkashi, D. G.; Balybin, E. S. (Moscow Medical Inst.). Med. Radiol.; 17: No. 9, 37-40(Sep 1972). (In Russian).

Iodine metabolism in 40 oncological patients with various localizations of malignant tumors was studied preceding gamma therapy by means of the whole-body radiometry. It was determined that most of them had lowered indices of iodine metabolism, the body organic iodine level in particular. In the process of gamma-therapy it was established that the same patients had a statistically reliable relationship between the organic iodine content in the body and the integral dose under which general radiation reaction developed. (auth)

12312 RADIATION INJURY TO LARGE ARTERIES. THREE FURTHER EXAMPLES WITH PROLONGED ASYMPTOMATIC INTERVALS. Benson, E. P. (Medical Center X-Ray, Inc., Yakima, WA). Radiology; 106: No. 1, 195-7(Jan 1973).

Clinical and angiographic findings in three cases of radiation injury to large arteries are presented in order to illustrate the remote effects of irradiation. The previous literature is reviewed, and the prolonged interval prior to the discovery of the abnormalities is discussed. (auth)

12313 APPLICATION OF PHYTOHEMAGGLUTININ (PHA) IN COMBINED TREATMENT OF SKIN RADIATION LESIONS. Sarkisyan, Yu. Kh.; Popov, V. I. (Moscow Medical Inst.). Med. Radiol.; 17: No. 7, 7-10(Jul 1972). (In Russian).

The technique is introduced for applying ointment and phytohemagglutinin (PHA) solution in treatment of skin and mucosa radiation lesions of different degree (erythema, dry and moist epidermitis, indurative edema and sclerosis, mucositis, radiation lesion). The effect of the preparation against the background of combined therapy was followed up in 85 patients with different degree radiation injuries of the skin. Clinical observations have illustrated that PHA is a highly biogenic stimulus; it increases the activity of proliferative tissues, stimulates regeneration, raises cell immunity, facilitates tissue granulation and epithelization, reduces the exudative phase, and accelerates that of proliferation. (auth)

12314 CHANGES IN THE PERIPHERAL BLOOD DURING TREATMENT WITH 25 MeV BREMSSTRAHLUNG OF PATIENTS WITH TUMORS OF THE BRAIN. Smirnov, R. V. (Leningrad Scientific-Research Neurosurgical Inst.). Med. Radiol.; 17: No. 7, 80-2(Jul 1972). (In Russian).

Changes in the number of formed elements of peripheral blood were observed in 112 patients with tumors of the brain and spinal cord. The irradiation was performed with either an electron beam or with a combination of an electron beam and bremsstrahlung. The blood elements studied and tabulated for discussion included segment nuclear neutrophils and lymphocytes. (KSW)

12315 DOSIMETRY IN INVESTIGATIONS ON NEUTRON-CAPTURE THERAPY. Ivanov, V. N. (Scientific-Research Inst. of Medical Radiology, Moscow). Med. Radiol.; 17: No. 7, 85-93(Jul 1972). (In Russian).

This survey covers the literature on neutron capture therapy using reactor beams or accelerators. Considerable work on phantom irradiation with thermal and epithermal neutrons, neutron capture nuclides, chemical dosimeters, and dose distribution is summarized. Burns and excess dosages as a result of deep-seated tumor irradiation and estimates of therapeutic dose levels for given tissue structures are discussed. An extensive bibliography is included. (KSW)

12316 NUCLEAR POWER STATIONS: ENVIRONMENTAL SURVEILLANCE OF RADIOACTIVITY. Pellerin, Pierre (Univ., Paris). Int. At. Energy Agency Bull.; 14: No. 3, 21-31(1972).

Because of the radiations they emit, radioactive substances can be detected, identified, and measured at extremely low concentrations. The corresponding masses are lower by a factor ranging from 1000 to 10,000 than those that can be measured by any other chemical or physical method, however precise, applied to non-radioactive substances. Radioisotopes can therefore be detected in the environment at levels much lower than those at which genuine public health problems begin to arise. Unfortunately, we cannot say the same of numerous non-radioactive pollutants, which can be measured only at concentrations very close to, or even exceeding, the toxicity threshold. In the mind of the uninformed public confusion seems quite frequently to reign as between the detection threshold and the toxicity threshold. This undoubtedly explains the following situation which is, to say the least, paradoxical: people are afraid of the hypothetical effects of radioactivity at ridiculously low levels, whereas nobody is alarmed at the fact that the toxicity limits for a very large number of non-radioactive, but very real pollutants are being exceeded almost continuously. The sum of all artificial irradiations does not exceed the normal fluctuations of natural irradiation, and if the genetic effects of very low radiation doses were truly cumulative,

the natural radiation to which we are all exposed, and which is by far the highest, would by itself have eliminated every trace of life on earth long ago. The use of x rays in diagnosis represents an additional average artificial irradiation of the population amounting to double the natural radiation dose (100 millirem per year). This is about 100 times the radiation dose which would accrue from nuclear industry even according to the most pessimistic estimate. Measures are described that will make it genuinely possible to maintain environmental radioactivity in all circumstances at a level which is perfectly compatible with public health regulations. Far from constituting a hazard to the public, nuclear power facilities can, by virtue of the strictness of the controls to which they are subjected, serve as a model for combatting numerous unacceptable conventional pollutants of the environment, the most alarming of which nuclear power will undoubtedly cause to disappear in the long run. (auth)

12317 RADIOSENSITIVITY AND RECOVERY POTENTIAL OF HUMAN BLOOD-FORMING TISSUES. COMPARISON OF MALIGNANT AND NONMALIGNANT STATES. Yuhas, J. M.; Stokes, T. R.; Lushbaugh, C. C. (Oak Ridge National Lab., TN). Radiology; 105: No. 3, 641-4(Dec 1972).

Peripheral WBC response was studied in patients exposed to whole-body irradiation for chronic myelogenous leukemia, chronic lymphatic leukemia, lymphosarcoma, and diseases having no direct effect on blood-forming tissues. With use of the WBC count at the nadir as a function of exposure level and time, it was determined that no significant radiosensitivity differences exist among the disease states of tissues giving rise to peripheral WBC. The data support the proposal that fractionation of the total exposure can preferentially allow recovery of normal tissues. (auth)

12318 LATE NEOPLASTIC CHANGES FOLLOWING MEDICAL IRRADIATION. Hutchison, G. B. (Harvard School of Public Health, Boston). Radiology; 105: No. 3, 645-52(Dec 1972).

In his analysis of the literature on radiation cancerogenesis, the author suggests (subject to further study) that (a) all malignancies may be stimulated by irradiation; (b) all types of radiation may be cancerogenic; (c) the risk is about 1 to 5 cases per million population per year per rad absorbed in relevant tissue for several sites; (d) the excess is manifested some limited number of years following a latent period (shorter for leukemia than for other malignancies); (e) chronic lymphatic leukemia is an apparent exception to the generality concerning all malignancies; and (f) fetal tissue may be several times more sensitive. Relatively high doses of radiation are either noncancerogenic or follow a different quantitative relationship from that seen at low doses. (auth)

12319 GENETIC PROBLEMS RELATED TO RADIOLOGY PRACTICES. Grahn, D. (Argonne National Lab., IL). Radiology; 105: No. 3, 653-7(Dec 1972).

Because of the projected rise in diagnostic radiation, there is great concern with concomitant genetic risks. Discussed are the nature of mutation, the rates applying to actual clinical practices, the biological and physical variables that influence these rates, and the present human burden of genetic defects and methods of predicting the consequences of increased exposure. Assuming an added exposure of 125 mrads per yr, an increase of 1.02 to 1.50 over the present burden of defects is calculated. If an increase of 10% is reasonable, the present burden of 6% could rise to 6.6% after many generations of exposure. (auth)

12320 RADIATION-INDUCED OR METASTATIC BRACHIAL PLEXOPATHY? A DIAGNOSTIC DILEMMA. Thomas, J. E.; Colby, M. Y. Jr. (Mayo Clinic and Mayo Foundation, Rochester, MN). J. Amer. Med. Ass.; 222: No. 11, 1392-5(11 Dec 1972).

Fourteen patients with presumed radiation plexopathy and 11 patients with metastatic involvement of the brachial plexus were studied. In both groups, plexopathy began after a mean interval of six years, the initial symptom usually being sensory. Almost half the patients with radiation damage had no significant pain; metastatic plexopathy characteristically was very painful. Plexus disease was progressive for an average of nine years in the radiation group, but metastatic plexopathy also sometimes progressed for years without distant metastasis. Sensation, muscle power, and stretch reflexes were affected similarly in both groups. All patients with radiation damage were alive as of this study; almost all with metastatic plexopathy were dead. No single clinical symptom or sign permitted distinction between the two groups. (auth)

12321 EVALUATION OF OPTICAL RADIATION HAZARDS. Sliney, D. H.; Freasier, B. C. (Army Environmental Hygiene Agency, Edgewood Arsenal, MD). Appl. Opt.; 12: No. 1, 1-24 (Jan 1973).

Methodology for the evaluation of potential optical radiation hazards was developed in response to the increasing use of high radiance optical sources, such as lasers, compact arc lamps, tungsten–halogen lamps, and electronic flash lamps. Recent biological investigations of injury from ultraviolet radiation and studies of chorioretinal injury from high radiance sources permit a realistic ocular hazard evaluation. Safe exposure criteria that may be readily applied to practical situations were developed from the available biological data and from experience with occupational hazards. Hazard evaluation techniques, hazard data, and general control measures are provided for a number of commonly encountered ultraviolet, visible, and infrared sources. (auth)

12322 KINETIC OF CHROMOSOME ABERRATIONS PRODUCTION IN HUMAN LYMPHOCYTES AFTER IN VITRO IRRADIATION OF PERIPHERAL BLOOD WITH FISSION SPECTRUM NEUTRONS WITH ENERGY OF 1 MeV. Melnikova, A. E.; Pyatkin, E. K.; Suskov, I. I.; Vorob'ev, A. I.; Tsvetkov, V. I. (Inst. of Biophysics, Moscow). Stud. Biophys.; 29: 211-16(1971). (In Russian).

Chromosome aberrations in lymphocytes of human peripheral blood were studied after irradiation with fission spectrum neutrons with a mean energy of 1 MeV at doses of 113, 197, 310, 417, and 518 rads. It was shown that the frequencies of chromosome fragments and dicentrics + rings increased linearly with the dose. (auth)

Vertebrates

Refer also to abstract 12207.

12323 (AD–746168) EFFECTS OF PULSED GAMMA–NEUTRON IRRADIATION ON THE EEG AND BEHAVIOR OF THE MONKEY. McFarland, W. L.; Levin, S. G. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Apr 1972. 44p. (AFRRI-SR-72-8). NTIS.

Cortical electroencephalograph (EEG) recording leads were implanted in seven rhesus monkeys (Macaca mulatta). The monkeys were then trained to perform a visual discrimination task. After the animals were trained to acceptable levels of performance, blood pressure measuring devices were surgically implanted. Two weeks after surgery, the monkeys were irradiated with a single 2500-rad whole-body pulse of mixed gamma-neutron radiation from the AFRRI-TRIGA reactor. EEG, behavioral, and cardiovascular parameters were continuously monitored and recorded on magnetic tape. Relationships between these EEG measures, behavioral changes, and cardiovascular alternations were then studied both preirradiation and postirradiation. Some degree of apparent relationship was found between changes in the EEG measures after irradiation and changes in performance, particularly during the early transient incapacitation (ETI) period. This relationship could not be well established in the period following ETI or between behavioral and cardiovascular changes. (auth)

12324 (AD–748119) PILOT STUDY OF THE INTERACTION OF EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS WITH BRAIN ORGANELLES. Riesen, W. H.; Aranyi, C.; Kyle, J. L.; Valentino, A. R.; Miller, D. A. (IIT Research Inst., Chicago, Ill.). Aug 1971. Contract N00039-71-C-0111. 29p. (IITRI-TM-3; IITRI-E-6185-3). NTIS.

Two types of subcellular particles (mitochondria and nerve ending particles) were exposed to extremely low frequency nonionizing electric and magnetic fields. The particles were isolated and placed in suspension in two identical test fixtures. An appropriate biochemical function was monitored for both the exposed and unexposed particles simultaneously. Biochemical changes were observed at 50 gauss and 155 volts per meter at 60 Hz and 0°C temperature. (auth)

12325 (BNWL–1650(Pt.1)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1971 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME I. LIFE SCIENCES. PART 1. BIOLOGICAL SCIENCES. Thompson, R. C. (ed.) (Battelle Pacific Northwest Labs., Richland, Wash.). Sep 1972. Contract AT(45-1)-1830. 329p. Dep. NTIS.

Separate abstracts were prepared for fourteen sections of the report. Two additional sections discuss cellular regulatory mechanisms and fine structural effects of temperature in fish. (HLW)

For abstracts of individual sections see: 12207, 12326–12328, 12357–12360, and 12366–12371.

12326 (BNWL–1650(Pt.1), pp 1-8) GASTROINTESTINAL IRRADIATION STUDIES. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Studies were conducted on factors affecting plasma protein leakage into the intestine of x-irradiated rats. Leakage was decreased by feeding a sodium deficient diet or by pre-treatment

with the radioprotective agent WR-2721. Other studies were conducted on gastrointestinal absorption and retention of plutonium chelates. It was found that the intestinal absorption of plutonium nitrate in rats was increased 700-fold when chelated with DTPA. Plutonium retention in the liver and skeleton was quite low but more than twice as high as when DTPA was not present. Citrate was less effective than DTPA in increasing absorption but more effective in increasing retention. (HLW)

12327 (BNWL-1650(Pt.1), pp 13-30) RADIATION EFFECTS ON CHYLOMICRON SYNTHESIS AND CAPILLARY PERMEABILITY IN MICE. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Mice were exposed to 1500 R whole-body x radiation and given ^{3}H-palmitic acid. The mice were killed at intervals, and examinations of intestinal and liver tissues showed that absorption and transport of lipids were normal for two days but failed later. X-irradiated mice were injected with peroxidase and various organs were prepared for microscopic study of capillaries. Permeability of the capillaries to peroxidase is discussed and photographs are presented to show capillary abnormalities. (HLW)

12328 (BNWL-1650(Pt.1), pp 295-301) BIOLOGICAL EFFECTS OF INTRACORPOREAL RADIOISOTOPE HEAT SOURCE. Gillis, M. F.; Decker, J. R.; Bingham, B. D.; Karaglanes, M. T.; Gordon, N. R.; Winegardner, W. K.; Cross, F. T. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Thoracic intraaortic implantation of heat exchangers containing 50 watt, medical grade $^{238}PuO_2$ heat sources for long-term studies of the effects of added endogenous heat and radiation in miniature swine presents a number of bioengineering problems. Through the implantation and 3-month evaluation of three sham devices and by subsequent dress rehearsal implantation of two control exchangers most of these problems have been solved. Five additional heat exchangers are under construction and will be implanted complete with their radioisotope heat sources as soon as those sources are received. Development of techniques for intra-abdominal implantation of such sources is in progress. (auth)

12329 (CONF-710501-56) RADIATION EFFECTS AND RADIONUCLIDE EXCRETION IN A NATURAL POPULATION OF PINE VOLES. Dunaway, P. B.; Story, J. D.; Kitchings, J. T. (Oak Ridge National Lab., Tenn.). 1972. Contract W-7405-eng-26. 31p. Dep. NTIS.

From 2nd national symposium on radioecology; Oak Ridge, Tenn. (10 May 1972).

Excretion rates of ^{60}Co and ^{54}Mn following injection of a tracer dose and the effects of acute γ irradiation on survival were measured in two groups (one in the field and one in the laboratory) of a population of pine voles (Microtus pinetorum). Field values were compared with laboratory data to ascertain whether interactions among radiation and natural environmental factors caused responses that were different from those of animals in the laboratory. Results indicate that radiation effects in the natural population were not significantly different from effects anticipated from laboratory experiments, excretion of ^{60}Co and ^{54}Mn was more rapid under field conditions than in the laboratory environment, and environmental factors had a greater effect than the radiation insult on the radionuclide excretion rate. (CH)

12330 (CONF-721051-2) EFFECTS ON AQUATIC BIOTA OF RADIOACTIVE EFFLUENTS FROM NUCLEAR POWER STATIONS. Blaylock, B. G. (Oak Ridge National Lab., Tenn.). 1971. Contract W-7405-eng-26. 13p. Dep. NTIS.

From Panel on radiation effects on population dynamics in ecosystems; Reykjavik, Iceland (2 Oct 1972).

Radioactive effluents released from nuclear power stations are one of the most rapidly increasing potential sources of radiation exposure to aquatic organisms. This paper considers the radiation dose to aquatic organisms living in an area receiving radioactive wastes from a representative nuclear power station, the effects of this dose, and the possible synergistic effects of radiation and temperature. Data used are from selected publications covering the effects of chronic low-level radiation and other environmental pollutants. (auth)

12331 (JPRS-57517, pp 59-68) POSSIBLE ROLE OF ANTITISSUE AUTOANTIBODIES IN THE PROTECTIVE MECHANISM OF LOCAL SHIELDING DURING TOTAL IRRADIATION. Klemparskaya, N. N.; Kashirin, V. S. Translation of Kosm. Biol. Med.; 6: No. 5, 38-44(1972).

Experiments on 115 white rats indicated that shielding of one hind leg considerably increased the number of antibodies eluted from the muscle tissue measured during the first 15 minutes after x irradiation. Shielding of the upper abdominal section, the most effective method for partial body protection, also induced a significant increase in the number of autoantibodies in the blood, spleen, and muscle tissue and an increase in the number of autoantibody-forming cells in the blood and liver. An increase in the number of normal autoantibodies during early post-irradiation stages exerts a protective effect since they have the capacity of binding and rendering harmless tissue products which are formed under the influence of ionizing radiation. (auth)

12332 (SAN-753) FINAL TECHNICAL REPORT [ON BIOLOGICAL RADIATION EFFECTS]. Austin, George (San Francisco Operations Office (AEC), Calif.). 22 Dec 1972. Contract AT(04-3)-753. 2p. Dep. NTIS.

Studies were made on acute radiation effects on synaptic activity in the mammalian spinal cord and effects on spinal cord reflexes are described. Other studies were conducted on effects of acute x radiation and whole light on single nerve cells in the abdominal ganglion of the mollusc, Aplysia californica. It was concluded that the central nervous system of the mollusc was more resistant to x radiation than that of the mammal. (HLW)

12333 EFFECT OF SURGICAL BURSECTOMY AND IRRADIATION ON ROSETTE-FORMING CELLS IN THE CHICKEN. Kiszkiss, D. F.; Choi, Y. S.; Good, R. A. (Variety Club Heart Hospital, Minneapolis). J. Immunol.; 109: No. 6, 1405-7(Dec 1972).

Surgical bursectomies were performed on 18 or 19 day old chicken embryos and after hatching the chickens were given 650 R of whole-body x radiation. Animals were sensitized with sheep erythrocytes and at intervals they were killed and the lymphoid organs removed. Cell suspensions were prepared and sheep erythrocytes were added. Cells binding four or more sheep erythrocytes were counted as rosettes and tables are presented to show comparisons between normal control and bursectomized-irradiated animals with respect to rosette-forming cells. Bursectomized and irradiated animals failed to show rosette formation when tested on days 0, 5, 9, and 14 after immunization. Results demonstrate abrogation of the humoral immune response while leaving cellular immunity intact and that such abrogation includes the antigen-binding as well as the antibody-secreting process. (H.L.W.)

12334 SYNTHESIS OF ACETYLCHOLINE IN THE FUNCTIONALLY DIFFERENT AREAS OF SPINAL CORD IN DYNAMICS OF ACUTE IRRADIATION SICKNESS. Snisar, I. A.; Reva, O. D. (Dnepropetrovsk State Univ., USSR). Ukr. Biokhim. Zh.; 44: No. 4, 497-9(1972). (In Ukrainian).

The intensity of acetylcholine synthesis was investigated in morphologically and functionally different areas of cat lumbar enlargement: grey matter of anterior and lateral horns, grey matter of posterior horns, and white matter as well as in the anterior and posterior spinal roots in different periods after total roentgen irradiation in a dose of 1200 R. A considerable increase in the intensity of acetylcholine synthesis in the tissues under investigation was found during initial periods of acute irradiation sickness—on the 5th to 6th day; at the terminal stage—on the 8th to 10th day its inhibition was observed. (auth)

12335 ROLE OF ENDOGENIC DOPAMINE IN RADIATION PROTECTION ACTION. Goncharenko, E. N.; Dzhanumova, T.; Zhat'kova, G. S.; Kudryashov, Yu. B. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 205: No. 2, 465-8(11 Jul 1972). (In Russian).

The administration of dopamine to animals resulted in a radiation protection action. In order to test this behavior further, experiments were conducted on white rats by intraperitoneal injections of MEA, cystamine, serotonin and histamine, or inducing hypoxia, and then analyzing the tissues of the liver, spleen, intestines, and the adrenal glands for endogenous dopamine and its precursor, dioxyphenylalanine (DOPA), about 15 min after treatment. As a rule, the injections of substances like cystamine, MEA, and serotonin raised the dopamine content in the tissues tested by about 150 to 200%. (K.S.W.)

12336 DOSIMETRIC INDEX OF THE SERIOUSNESS OF ACUTE RADIATION INJURY. Keirim-Markus, I. B. Med. Radiol.; 17: No. 7, 32-5(Jul 1972). (In Russian).

The probability of injury/destruction during the hematological form of radiation sickness may be treated as a probability that the number of viable trunk cells of the bone marrow becomes smaller than some minimum value. This offers a possibility of characterizing the degree of damage, and during the nonuniform irradiation of an organism in some equivalent dose D*, the expression $f(D^*) = 1/M \int m(D)\, f(D)\, dD$, applies, where f(D) is the mortality curve, M is the mass of bone marrow, and m(D) dD is the distribution of dose loading throughout the bone marrow. The possibility of disseminating this model to special forms of radiation injury was examined. (tr-auth)

12337 MECHANISM OF METHEMOGLOBIN FORMATION IN RADIATION PATHOLOGY. Zdravko, B. I. (Lvov State

Univ.). Med. Radiol.; 17: No. 7, 82-4(Jul 1972). (In Russian).

The mechanism of methemoglobin formation under the influence of x radiation (600 R) was studied in 50 guinea pigs. Leukopenia and anemia were noted, and the concentrations of the blood components methemoglobin, erythrocytes, leukocytes, and hemoglobin were measured. (KSW)

12338 EXAMINATION OF THE CARCINOGENIC AND COCARCINOGENIC EFFECTS OF GRENZ RADIATION. Epstein, J. H. (Univ. of California, San Francisco). Cancer Res.; 32: No. 12, 2625-9(Dec 1972).

The effects of the chemical carcinogen 7,12-dimethylbenz(a)-anthracene on long-wavelength ionizing radiation (grenz ray)-induced carcinogenesis in the skin of hairless mice were examined. A carcinogenic amount of the grenz energy (20,500 R) was applied over a 12-month period. A single application of 7,12-dimethylbenz(a)anthracene 4 weeks before the initiation of the grenz ray exposures resulted in a significant acceleration of tumor growth and the incidence of deeply invading cancers. These findings simulate the influence of 7,12-dimethylbenz(a)anthracene ultraviolet-induced cancer formation, and confirm the additive effects of physical and chemical carcinogenic stimuli. (auth)

12339 MODEL SYSTEM FOR THE EVALUATION OF THE ROLE OF CHOLESTEROL α-OXIDE IN ULTRAVIOLET CARCINOGENESIS. Black, H. S.; Douglas, D. R. (Baylor Coll., Houston, TX). Cancer Res.; 32: No. 12, 2630-2(Dec 1972).

Cholesterol α-oxide (cholestan-5α,6α-epoxy-3β-ol), known to be carcinogenic, was formed in the skin of hairless mice in response to uv radiation. The levels of compound formed were dose dependent. Three criteria, namely, comparable effects by both the primary incitant (ultraviolet light) and cholesterol α-oxide, the same predisposing specificity, and a direct relationship between the ability of the primary incitant to form tumors and produce cholesterol α-oxide, are suggested as the minimum required to establish a causal involvement of this compound in the etiology of uv carcinogenesis. (auth)

12340 URETHAN AND X-RAY EFFECTS ON MICE OF A TUMOR-RESISTANT STRAIN, X/Gf. Goldfeder, A. (New York Univ., NY). Cancer Res.; 32: No. 12, 2771-7(Dec 1972).

Inbred X/Gf mice with an extremely low incidence of spontaneous neoplasms were tested for their response to urethan and x irradiation. Newborn, infant, and adult mice of both sexes were treated weekly with various doses of urethan [0.5 mg/g body weight (7 times) for newborn mice; 1.0 mg/g body weight (12 times) for infant and adult mice applied i.p., and 24 mg/mouse/week applied cutaneously]; with x irradiation ranging from 300 rads (1 time) to 80 rads (10 times) and with combined treatments [urethan, 1.0 mg/g body weight (4 to 12 times) and x irradiation, 75 to 150 rads (4 times)]. The incidence of neoplasms was very low in all age groups regardless of the mode of treatment, and it reached 3.4% for the total of 1023 mice. The only statistically significant difference was noticed between the group subjected to combined treatments and pooled data on all experimental groups ($p < 0.05$ for the "both-tail" test). Differences between other modes of treatment and between pooled data for both sexes were not statistically significant. Among 38 recorded neoplasms, 18 were thymomas of the lymphoblastic type, 13 were thymomas of the lymphocytic type, 3 were reticulum cell sarcomas, and 4 were mammary tumors. The very low incidence of neoplasms induced by urethan and x irradiation in X/Gf mice is explained on the basis of their high endogenous immune competence, the absence of leukemia viruses, and the very low incidence of mammary tumor virus. (auth)

12341 ELECTRON MICROSCOPIC STUDY OF NEOPLASMS INDUCED BY URETHAN AND X-RAYS IN X/Gf MICE. Goldfeder, A. (New York Univ., NY). Cancer Res.; 32: No. 12, 2778-92 (Dec 1972).

This study involves a search for ultrastructural characteristics and for the presence of oncogenic viruses in neoplasms induced in X/Gf mice by urethan, by x irradiation, or by a combination of both agents. The ultrastructural features of mammary carcinomas and thymic lymphomas of the lymphoblastic type are described. Mammary tumors were characterized by closely adjacent cells, frequently connected by desmosomes, by hypertropic surface microvilli that extended into the lumen of acini, and by a great variation in size and shape of nuclei. Mitochondria varied in number, shape, and size from cell to cell in microscopic sections of the same tumor. Nuclei of bizarre shape showed deep invaginations of the nuclear envelope. Characteristic mammary tumor virus type A and B particles were noted in 2 of 18 carcinomas investigated. Lymphoblastic thymic lymphomas were characterized by vastly distended cytoplasm with numerous mitochondria, by an abundance of ribosomes and polysomes, and by single and multiple projections of the nuclear envelope embracing portions of the cytoplasm. Dense bodies were frequently noted in cytoplasm and in mitochondria. Type A virus particles were observed in 1 of 19 thymic lymphomas. It is inferred that the type A virus particles in one thymic lymphoma and the mammary tumor virus in two mammary tumors were present in a latent state in these X/Gf mice before they were subjected to treatments. Most recent serological tests revealed that a small percentage of X/Gf mice are susceptible to mammary tumor virus, confirming the electron microscopic observations. The deep and extensive invaginations of the nuclear membranes, hypertrophic microvilli in mammary carcinoma cells and extensive single and multiple projections of the nuclear membranes of thymic lymphoma cells may be indicative of participation of the membrane systems of target cells in neoplastic transformation. (auth)

12342 RELEASE OF THYMIDINE FROM X-IRRADIATED SPLEEN IN THE RABBIT AS DETERMINED BY A NEW BIOASSAY. Maurice, P. A. (Roswell Park Memorial Inst., Buffalo). Cancer Res.; 32: No. 12, 2799-2802(Dec 1972).

Plasma collected from the spleen of rabbits 2 to 4 hr after selective splenic irradiation decreased from 75 to 95% the uptake of ^{125}I-labeled 5-iodo-2′-deoxyuridine by a suspension of bone marrow cells from untreated rabbits. The factor responsible for the decreased uptake was found to be dialyzable and, on paper chromatography in four different solvent systems, had the same R_f values as did thymidine. Serial dilutions of this factor gave a dose-related response in the bone marrow suspensions that was identical to that obtained with thymidine, 0.01 to 0.25 μg/ml, confirming the chromatographic identification of the plasma factor as thymidine. The extent of thymidine release as measured by this sensitive method may be useful in evaluating early cell damage following x irradiation. (auth)

12343 EFFECT OF IRRADIATION ON MOUSE SALIVARY GLANDS DURING THE PREREPLICATIVE PHASE OF ISOPROTERENOL-STIMULATED DNA SYNTHESIS. Sasaki, T.; Toda, M. (Tokyo Medical and Dental Univ.). Cancer Res.; 32: No. 12, 2807-12 (Dec 1972).

When mice were given a single injection of isoproterenol (IPR), the salivary gland cells were stimulated to enter DNA synthesis in a fairly synchronous manner after a lag period of about 18 hr. Gamma irradiation of these cells in the early prereplicative phase effectively inhibited the stimulation of DNA synthesis caused by IPR. However, irradiation in the late prereplicative phase or in mid-DNA synthesis phase was less effective in inhibiting IPR-stimulated DNA synthesis. The administration of a sialogog, pilocarpine, prior to irradiation did not affect the inhibitory effect of irradiation on the response of salivary gland cells to IPR. These results indicate that the highly radiosensitive phase, 1 hr after the second injection of IPR, was not related only to the ability of IPR to produce secretion in the salivary glands but was related rather to the early biochemical events leading to DNA synthesis in salivary gland cells. (auth)

12344 EFFECTS OF CONTINUOUS GAMMA RADIATION ON THE LIFE SPAN OF MICE. Muramatsu, S. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 13: No. 4, 230-3(Dec 1972).

Virgin female mice, CF#1 strain, were continuously irradiated with ^{60}Co gamma rays at a dose rate of 6 R/day from conception to natural death. A marked life shortening was found for the irradiated group. The mean life span of irradiated group was 384 ± 25 days (the mean accumulated dose being 2307.7 R), while that of the nonirradiated control group was 642 ± 12 days. (auth)

12345 KINETICS OF THE BONE MARROW CELLS IN THE BLOOD IN LONG-TERM GAMMA-IRRADIATION. Ilyukhin, A. V.; Burkovskaya, T. E.; Zubenkova, E. S.; Semashko, L. L.; Markelov, B. A. Med. Radiol.; 17: No. 12, 58-64(Dec 1972). (In Russian).

The kinetics of the cells of erythroblastic and leukoblastic series of hemopoiesis was investigated in dogs according to the time of generation, rate of renewing precursors of erythrocytes and granulocytes, as well as by the rate of renewing and value of bone marrow production of mature erythrocytes and granulocytes in the peripheral blood. It was shown that long-term (3-yr), continuous gamma irradiation of ^{60}Co in a dose of 125 rad a year and combined (repeated irradiations once in 4 months in a dose of 42 rad against the background of a constant chronic dose of 62 rad per year) caused changes of the kinetics of hemopoietic elements. These changes manifested themselves by shortening the time of generation and increase of the speed of renewing cell populations on the level of polychromatophil erythroblasts and myelocytes. There was also observed an increased rate of renewing mature granulocytes and erythrocytes in the peripheral blood. Intensification of the processes of proliferation of the cells fully com-

pensated the processes of radiation affection. The erythrocyte count remained constant during all the terms of investigation. In the leukoblastic shoot there was observed an insufficient activation of the function, this causing significant reduction of the number of bone marrow elements of hemopoiesis and mature granulocytes beginning from the 24th month of irradiation. On the basis of compared data characterizing the condition of erythroblastic and leukoblastic systems of hemopoiesis there is a suggestion concerning severe radioaffection of the latter. (auth)

12346 EFFECT OF IONIZING RADIATION ON THE PHYSIOLOGICAL REGENERATION OF RAT KIDNEY AT HIGH ALTITUDES. Sharipov, F. Kh. (Tadzhik State Medical Inst., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 10, 67-9(1972). (In Russian).

The effect of x rays on the mitotic activity of the epithelium of rat kidney was studied at low and high altitudes (3,379 m above sea level). For either altitude, seven groups of white rats (35/group) were subjected to 400 R of x radiation and the mitotic activity was studied 1, 2, 5, 10, 15, 30, and 60 days later. The data showed that suppression of mitotic activity of kidney epithelium was greater in rats irradiated at high altitudes. (KSW)

12347 RADIATION EFFECTS IN FREE-RANGING POCKET MICE, PEROGNATHUS PARVUS, DURING THE BREEDING SEASON. O'Farrell, T. P.; Hedlund, J. D.; Olson, R. J.; Gilbert, R. O. (Battelle-Northwest, Richland, WA). Science; 179: No. 4070, 289-91(19 Jan 1973).

Captive and free-ranging Great Basin pocket mice, Perognathus parvus, were exposed to ionizing radiation during the breeding season, April to June, in 1971. The values for the median lethal dose (LD_{50}) at 30 days plus or minus the standard deviation were 880 ± 14 rads and 780 ± 27 rads, respectively, and the slopes of the survivorship curves were significantly different. These differences suggested that there was a synergism between radiation-induced and environmental sources of mortality, since the field data were corrected for natural mortality (5%) in the controls. (auth)

12348 MORPHOLOGICAL ALTERATIONS IN THE TESTICLES OF GUINEA PIGS DURING TOTAL LOCAL X RADIATION. Bregadze, M. A.; Lagidze, T. P. (Inst. Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk. Gruz. SSR; 68: No. 3, 752-6 (Dec 1972). (In Russian).

Total as well as local (head and body separately) exposure of the animals to x-radiation results in morphological alterations in the testicles. Damage of the testicles manifests itself earlier during total rather than local exposure. The alterations are, however, evidenced earlier during local exposure of the head than that of the body. (auth)

Invertebrates

12349 AGE-DEPENDENT CHANGES OF RADIOSENSITIVITY IN EMBRYO OF BOMBYX MORI. Murakami, A. (National Inst. of Genetics, Misima, Japan); Miki, M. J. Radiat. Res.; 13: No. 4, 183-92(Dec 1972).

The changes in radiosensitivity during embryogenesis of the silkworm, Bombyx mori L., were investigated. The radiosensitivity expressed as LD_{50}(R) values was estimated from the dose-hatchability curves obtained following irradiation with x rays and ^{137}Cs gamma rays. Data obtained in the present study together with results previously reported indicated that the radiosensitivity generally decreased as the embryonic development proceeded and that the age-dependent change in radiosensitivity may strongly depend on the degree of morphogenesis. From the viewpoint of the marked differential stage sensitivity, the process of embryogenesis may be divided into two main phases: one is a sensitive phase that corresponds to the time prior to and during blastokinesis (or before the completion of the embryonic morphogenesis) and the other is an extremely resistant phase that corresponds to the stage after blastokinesis. The former embryo was about 10 times as high in radiosensitivity as the latter embryo. The implication of these results was discussed. (auth)

12350 EFFECTS OF POST-IRRADIATION INCUBATION ON THE FIBROIN SYNTHETIC ACTIVITY OF SILKGLAND RIBOSOMES. Kobayashi, T.; Matsumoto, K.; Yoshii, G. (Hokkaido Univ., Sapporo). J. Radiat. Res.; 13: No. 4, 214-20(Dec 1972).

Isolated silkgland ribosomes were irradiated with x rays, and their activities to synthesize fibroin in vitro were examined. A marked decrease in their activities was observed when ribosomes were incubated at 37°C following x irradiation. Per cent decrease in the ribosomal activity leveled off at 37°C after 30 min incubation. The extent of decrease was dependent on x-ray dose. Treatment of ribosomes with pancreatic ribonuclease showed a decrease in the ribosomal activity. These results suggest that a type of radiation damages on irradiated ribosomes is likely to be revealed during the post-irradiation incubation period through a possible interaction with ribonuclease either activated or released by x irradiations. (auth)

12351 MATING COMPETITION OF IRRADIATED AND NORMAL MALES WITH NORMAL FEMALES OF THE QUEENSLAND FRUIT FLY, DACUS TRYONI (FROGG.). Bhatti, M. A. (Pakistan Atomic Energy Commission, Karachi); Shipp, E. Nucleus (Karachi); 9: No. 1-2, 107-10(1972).

The mating ability of the irradiated males of Dacus tryoni in competition with normal males was investigated. The frequency of mating among the irradiated males was most favorable at doses of 5 and 7.5 Krad and thereafter it steadily diminished at higher doses. In an intensive competition, completely sterilized males at 9 and 10 Krad mated less frequently than the normal males, whereas the partially sterilized males at 5 and 7.5 Krad competed successfully. The increase of cage size did not affect the mating activity of males at the substerilizing dosages, whereas it further deteriorated at the total sterilizing dosages. (auth)

12352 IONIZIRUYUSHCHIE IZLUCHENIYA V BOR'BE S VREDNYMI NASEKOMYMI. (Ionizing Radiations in Control of Destructive Insects). Klimpinya, A. E. Riga; Izdatel'stvo Zinatne (1971). 132p.

The sexual sterilization of insects by means of ionizing radiations is discussed. The sensitivity of insects to radiation is compared at different phases of the life cycle, and the survival and mating activity of the irradiated adults are discussed. Pathological changes in the sex organs of irradiated insects are analyzed. Prospects for sexual sterilization of certain flies by this technique are considered. Preparation of culture media, including synthetic and aseptic types, for feeding and propagating insects is described. (502 references) (KSW)

12353 RADIATION BIOPHYSICAL INVESTIGATIONS OF DROSOPHILA MELANOGASTER. III. ACTION OF X-RAYS AND FAST NEUTRONS ON THE PRIMARY AND SECONDARY NON-DISJUNCTION OF X-CHROMOSOMES IN DROSOPHILA. Glottoff, N. W. (Univ., Halle, Ger.); Berg, W.; Bubnov, Yu. I.; (and others). Stud. Biophys.; 29: 217-24(1971). (In German).

The action of x rays (average LET 1.6 KeV/mcm) and fast neutrons (average LET about 30 to 35 KeV/mcm) on the primary and secondary non-disjunction and loss of X chromosomes in females of D. melanogaster were compared. The genotypes of the females and the frequencies of spontaneous non-disjunction and loss are shown. In preliminary experiments, it was found that: with the frequencies of spontaneous non-disjunction being rather low, the frequencies of radiation-induced chromosome non-disjunction are not essentially influenced by LET; with the frequencies of spontaneous non-disjunction being high, the decrease of the frequencies induced by irradiation is greater following the neutron irradiation; and the frequency of chromosome loss increases with dose of irradiation much quicker following neutron as compared with x irradiation. The results confirm the earlier proposed hypothesis. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstract 12308.

12354 (CEA-CONF-2125) CONTAMINATION BY OSTEOTROPIC β EMITTERS. AN EVALUATION OF THE DOSES IN BONE MARROW AND ENDOSTEUM: EFFECT OF AGE. Le Grand, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 19p. (CONF-720818-4). Dep. NTIS (U. S. Sales Only).

From second international conference on strontium metabolism; Glasgow and Strontian, Scotland (16 Aug 1972).

A method is described for estimating the β radiation dose absorbed by the bone marrow and endosteal tissues of the vertebrae following the uptake of ^{90}Sr by humans of various ages. Published data on the length of the bone trabeculae in individuals of various ages were used in the estimations. (CH)

12355 RADIATION DOSE TO BREAST-FEEDING CHILD AFTER MOTHER HAS ^{99m}Tc-MAA LUNG SCAN. Berke, R. A.; Hoops, E. C.; Kereiakes, J. C.; Saenger, E. L. (Cincinnati General Hospital). J. Nucl. Med.; 14: No. 1, 51-2(Jan 1973).

The administration of radiopharmaceuticals to nursing mothers requires consideration of radioactivity received by the infant. Following administration of 2 mCi of ^{99m}Tc-macroaggregated albumin, estimations of radioactivity in breast milk indicate that nursing could be resumed after 24 hr. (auth)

12356 CALCULATING THE RADIATION DOSE TO AN ORGAN. Cloutier, R. J.; Watson, E. E.; Rohrer, R. H.; Smith, E. M. (Oak Ridge Associated Universities, TN). J. Nucl. Med.; 14: No. 1, 53-5(Jan 1973).

The Medical Internal Radiation Dose (MIRD) Committee of the Society of Nuclear Medicine has developed basic equations for calculating the radiation dose to a patient from a radiopharmaceutical. These equations are analyzed and modified so that the dose to a specific organ may be calculated when the radionuclide is not uniformly distributed in the body. Without the modifications, the dose to a target organ may be overestimated because the amount of radionuclide in the organ is included in the equation twice. (auth)

Animals

Refer also to abstracts 12325, 12330, and 12370.

12357 (BNWL-1650(Pt.1), pp 9-11) EFFECTS OF IRRADIATING SKIN. Mahlum, D. D. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Observation of pigs, which were exposed to 1 to 40 krads of beta radiation from ^{204}Tl plaques approximately 3 years ago, continues. Areas that were exposed to 6, 15, or 40 krad when the animal was an adult appear as thin whitened circles with an area only slightly larger than that originally exposed. Areas that received 1 or 2.5 krad are not grossly visible. In contrast, in animals exposed as neonates, lesions were noted at 2 krad and the affected area was several times that originally irradiated. Additional analyses have been obtained from tissues from pigs that received ^{239}Pu intradermally 8 to 10 years ago. No skin tumors have yet been found. The concentration of ^{239}Pu in liver was as great as, or greater than, that in bone. Estimated radiation dose to the liver ranged between 65 and 465 rads per year based on the concentration of ^{239}Pu in the liver at time of death. (auth)

12358 (BNWL-1650(Pt.1), pp 31-5) MINIATURE SWINE AS MODEL FOR INTRACAVITARY IRRADIATION. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Techniques were developed using the Hanford Miniature Swine that will allow a comparison of the effects of ^{226}Ra capsules implanted in the uterine cervix with those resulting from implanted ^{252}Cf afterloading capsules. These methods should allow calculation of an RBE for this neutron emitter. (auth)

12359 (BNWL-1650(Pt.1), pp 121-5) RADIATION-INDUCED LEUKEMOGENESIS. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

The type C virus isolated from leukemic miniature swine that had been chronically exposed to ^{90}Sr was partially characterized. This virus was shown to have chemical, physical, and morphological properties similar to those of viruses known to cause leukemia in other animal species. Control and ^{90}Sr-exposed swine were sensitized to complete Freund's adjuvant, and cellular immunity was determined, using the macrophage migration inhibition technique. These studies indicate that chronic exposure to ^{90}Sr has an inhibitory effect on the normal cellular immune response of miniature swine. (auth)

12360 (BNWL-1650(Pt.1), pp 231-51) INHALATION HAZARDS TO URANIUM MINERS: BIOLOGICAL STUDIES. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on studies on the effects of life-span inhalation exposures of hamsters to radon daughters, uranium ore dust, and Diesel exhaust fumes and of effects of life-span inhalation exposures of beagle dogs to radon daughters, uranium ore dust, and cigarette smoke. (HLW)

12361 (LIB/Trans-469) DOSE TO THE EPITHELIUM OF THE UPPER RESPIRATORY TRACT FROM RADON AND ITS DAUGHTER PRODUCTS. Bykhovskii, A. V.; Khachirov, D. G.; Shishkanov, N. G.; Dubrovin, S. A.; Klyuch, V. E. Translated by P. Pakalns (Australian Atomic Energy Commission Research Establishment, Lucas Heights) from Health Phys.; 23: 13-22 (Jul 1972). 17p. Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA 26: 45861 (1972). (auth)

12362 DEPENDENCE OF CHANGES IN THE SKELETAL SYSTEM ON β-RADIATION DOSE OF INCORPORATED ^{90}Sr. Shvedov, V. L.; Tuzhilkova, T. N.; Semenova, V. P. Med. Radiol.; 17: No. 7, 46-51(Jul 1972). (In Russian).

The authors have studied the influence of wide spectrum tissue doses on the structure of tubular bone in mature rats. The experimental data indicate that the absorbed dose including initial changes in the femur is 2,000 rads.

12363 FURTHER COMMENTS ON ESTIMATION METHODS OF ABSORBED DOSES DUE TO TRITIUM. Shiragai, A. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 13: No. 4, 208-13(Dec 1972).

The absorbed doses in a cell nucleus from β particles emitted by incorporated tritium atoms in the nucleus are estimated on the basis of energy dissipation algorithm as follows; the energy dissipated at depth t by a beam containing one electron/cm^2 may be represented as $d(\eta E)/dt$, where η is the probability of transmission and E the residual energy. The absorbed doses that were calculated with constant absorption model in the previous work are found to agree well with the present results. It is known that the results that are obtained by using the average energy of ^{3}H β particles are appreciably different from the ones based on the β-spectrum. Furthermore the calculated results are compared with the other estimation methods and the conclusions deduced from these models are briefly explained. (auth)

Plants

12364 EFFECT OF THE RADIOACTIVE POLLUTION OF THE SOIL WITH ^{90}Sr ON VARIABILITY IN SOME ORGANISMS. Krivolutskii, D. A.; Smurov, A. V.; Snetkov, M. A. (Inst. of Evolutionary Morphology and Ecology, Moscow). Zh. Obshch. Biol.; 33: No. 5, 587-91(1972). (In Russian).

Experimental contamination of the soil with ^{90}Sr at 0.6 to 3.4 μCi per m^2 led to an increase of variability and to changes of some morphological characters in two geophilid species and two herbacious plant species (Leucanthemum vulgare L. and Achillea millefolium L.) as compared with the control. An increase in the rate of anomalies in the populations on the contaminated plot was noted. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstract 11978.

Man

Refer also to abstract 11990.

12365 FORECAST OF FUTURE ^{90}Sr AND ^{137}Cs BURDEN IN MAN IN SLOVAKIA. Csupka, S. (Regional Hygienic Station, Bratislava). Bratislav. Lek. Listy; 57: No. 3, 271-81(Mar 1972). (In Slovak).

Methods of investigating the radiation burden for the human organism resulting from radioactive fallout are briefly reviewed. Using models for predicting the deposition of ^{90}Sr and ^{137}Cs in the bones and in the soft tissues, respectively, elaborated earlier, the values were calculated of estimated radioactive burden from the two radionuclides for the population of Slovakia in the period between 1970 and 2000. The estimation was based on the daily intake of ^{90}Sr and ^{137}Cs with foodstuffs. The results are tabulated. (NSA of Czech.)

Animals

Refer also to abstract 11983.

12366 (BNWL-1650(Pt.1), pp 71-92) METABOLISM AND EFFECTS OF RADIONUCLIDES IN THE DEVELOPING FETUS AND THE YOUNG. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on the following studies: carcinogenicity of ^{131}I in rats relative to age at exposure; influence of age on the late effects of monomeric ^{239}Pu in the rat; ^{239}Pu and the liver of the immature rat; distribution and subacute toxicity of ^{253}Es in weanling and adult rats; distribution of ^{253}Es in the fetoplacental unit of the rat; and ^{253}Es and ^{249}Bk distribution in rat tissues following intragastric and intravenous administration. (HLW)

12367 (BNWL-1650(Pt.1), pp 93-119) EFFECTS OF RADIOSTRONTIUM IN MINIATURE SWINE. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on the following studies on miniature swine: toxicity of chronic ^{90}Sr ingestion; uterine-milk exposure study of ^{90}Sr effects; the chemical forms of hydroxyproline in plasma exposed to ^{90}Sr; alkaline phosphatase isoenzymes in ^{90}Sr-

treated swine; effects of ^{90}Sr on phytohemagglutinin stimulation of peripheral lymphocytes; porcine and human chromosome aberrations induced by in vitro exposure to x rays or $^{90}Sr-^{90}Y$. A study was also conducted on sequestration of heat-damaged erythrocytes as a measure of reticuloendothelial function in cats ingesting ^{90}Sr daily. (HLW)

12368 (BNWL-1650(Pt.1), pp 127-75) INHALATION STUDIES. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on the following studies: characterization of $^{239}PuO_2$ aerosols generated for inhalation toxicity studies with experimental animals; carcinogenicity of plutonium dioxide, asbestos, and benzpyrene in the abdominal cavity of rats; the disposition of ingested, injected, and inhaled ^{239}Pu citrate and ^{239}Pu nitrate; distribution and clearance of inhaled samarium and promethium oxides in rats; removal of inhaled $^{239}PuO_2$ from beagle dogs; acute toxicity of DTPA administered intratracheally; a method for intratracheal instillation; and development of an isolated organ preparation for studying effects of toxic materials on lung tissue metabolism. (HLW)

12369 (BNWL-1650(Pt.1), pp 177-230) LOW-LEVEL PLUTONIUM INHALATION STUDIES IN BEAGLES. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on the following studies on beagles: relationships between the size distribution of $^{239}PuO_2$ aerosols, aerosol concentration, and nebulizer suspension concentration; alveolar deposition of $^{239}PuO_2$ aerosols in beagle dogs as a function of respiration and aerosol parameters; relationships between respiration parameters of unanesthetized adult beagle dogs during training and during $^{239}PuO_2$ aerosol inhalation exposures; an instrument for rapid determination of concentration of alpha-emitting aerosols for use in inhalation studies in animals; and an instrument for continuous monitoring of tidal volume of beagle dogs during exposure by inhalation of radioactive aerosols. (HLW)

12370 (BNWL-1650(Pt.1), pp 253-71) SPACE NUCLEAR SYSTEM STUDIES. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on studies on metabolism of soluble ^{238}Pu from crushed $^{238}PuO_2$ microspheres following intratracheal or intra-abdominal injection in rats and carcinogenicity in rats of inhaled ^{238}Pu from crushed microspheres. (HLW)

12371 (BNWL-1650(Pt.1), pp 273-86) REMOVAL OF INTERNAL EMITTERS. Sep 1972.

In Pacific Northwest Laboratory annual report for 1971 to the USAEC Division of Biology and Medicine.

Progress is reported on studies on interaction of ^{238}Pu and ^{144}Ce during chelation therapy in rats; in vitro binding of ^{239}Pu by $CaNa_3DTPA$; distribution of $^{253}Es(NO_3)_3$ in rats after intravenous, intramuscular, subcutaneous, and transcutaneous administration; and chelation therapy for the decorporation of ^{253}Es from rats using Zn- and Ca-DTPA. (HLW)

12372 ^{137}Cs IN TISSUES OF THE LIZARD, HEMIDACTYLUS LESCHENAULTI. Narayanan, N.; Eapen, J. (Bhabha Atomic Research Centre, Trombay, India). J. Anim. Morphol. Physiol.; 18: No. 2, 171-5(1971).

The influence of temperature on the uptake of ^{137}Cs by a lizard was investigated. The results show that radiocesium uptake by cardiac muscle, kidney, and liver is not influenced by temperature during short time intervals. Retention of the radionuclide over a period of time, however, changes as a function of temperature. Thus, at 24°C, retention of ^{137}Cs is considerably higher than at 37°C, 24 hr after administration. The inference is that retention of ^{137}Cs in poikilotherms is enhanced by acclimation to low temperature. Skeletal muscle (white) is unique in that it does not show temperature dependent changes in radiocesium retention. It was observed that regenerating tail of lizards accumulates about 3 times more ^{137}Cs than nonregenerating tail at high as well as at low temperatures. The significance of the temperature dependent distribution of ^{137}Cs is discussed. (Indian Sci. Abstr.)

12373 EFFECT OF URANIUM NITRATE ON THE FUNCTIONING OF THE THYROID GLAND OF THE RAT. Malenchanka, A. F.; Kazyuk, G. V. (Inst. of Nuclear Energy, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 6, 71-5(1972). (In Belorussian).

The effect of large doses of uranium nitrate on the functional state of the thyroid gland in the rat was studied. Uranium nitrate causes an inhibition of inorganic and organic phases of iodine exchange. The degree of suppression of thyroid function was proportional to the uranium dose. The morphological manifestation of the uranium intoxication in the thyroidal parenchyma was the destruction of follicles, desquamation, and local proliferation of the follicular epithelium. (tr-auth)

12374 STUDIES ON THE METABOLISM OF SOME CHEMICAL SPECIES OF RADIORUTHENIUM IN THE RAT. I. EARLY FATE OF INGESTED RUTHENIUM. Enomoto, Y.; Watari, K.; Ichikawa, R. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 13: No. 4, 193-8(Dec 1972).

The whole body retention of three chemical species of ^{106}Ru was studied in rats. Three ruthenium species were a ruthenium chloro complex (Ru-chloro), a nitrosyl ruthenium nitrate complex (RuNO-nitrato), and a nitrosyl ruthenium nitro complex (RuNO-nitro). When the compounds were administered orally, the RuNO-nitro complex showed the highest retention, while the RuNO-nitrato and Ru-chloro complexes demonstrated a comparably low retention. The cumulative urinary excretion for three days of the RuNO-nitro complex was the highest. The excretion of the RuNO-nitrato was slightly but significantly higher than that of the Ru-chloro complex. When the compounds were injected intravenously, the whole-body retention of the Ru-chloro complex was the highest, followed by the RuNO-nitrato and the RuNO-nitro in this order. These results suggest that the RuNO-nitro complex was absorbed more readily through the gastrointestinal wall to the body than the RuNO-nitrato and the Ru-chloro and that the RuNO-nitro and -nitrato complexes in the body were metabolized and excreted faster than the Ru-chloro complex. (auth)

12375 ACCUMULATION OF STRONTIUM AND CALCIUM IN FRESHWATER FISHES OF JAPAN. Suzuki, Y.; Nakamura, R.; Ueda, T. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 13: No. 4, 199-207(Dec 1972).

The ^{90}Sr content in bones of freshwater fishes (carp and gibel) from radioactive fallouts was investigated in relation to those in the surrounding waters from 1963 to 1970. The specific activities ($^{90}Sr/Sr$) of fish bones and of the surrounding waters declined rapidly from 1963 to 1964, followed by a gradual decline from 1964 to 1970. The specific activities of fish bones were always slightly higher than those of the waters, except that of gibel in 1963. The time lag between Sr specific activities of fish bones and those of surrounding waters were 270 days for carp and 360 days for gibel. The discrimination between stable Sr and Ca in freshwater fishes was demonstrated: In the field studies, the Sr/Ca observed ratio (OR) were determined as 0.74 ± 0.05 for carp and 0.84 ± 0.07 for gibel, respectively. In rearing experiments, the Sr accumulation of carp reared in the water of 2×10^{-1} mg Ca/l was twice as much as that in water of 2×10^{2} mg Ca/l. It is now possible to estimate ^{90}Sr content in the bones of carp and gibel by using their OR values and the time lag of Sr specific activity between the freshwater fish bone and the surrounding water. (auth)

12376 EFFECTS OF $^{90}Sr + ^{90}Y$, ^{65}Zn, AND ^{51}Cr ON THE LARVAE OF THE PACIFIC OYSTER CRASSOSTREA GIGAS. Nelson, V. A. (Univ. of Washington, Seattle). pp 819-32 of Columbia River Estuary and Adjacent Ocean Waters. /Pruter, A. T. (ed.). Seattle; Univ. of Washington Press (1972).

The effects of ionizing radiation on the larvae of marine molluscs have been little investigated. The purpose of this study was to determine the concentrations of four radionuclides (^{65}Zn, ^{51}Cr, and $^{90}Sr + ^{90}Y$) and two stable elements (zinc and chromium) which were required to produce abnormal larvae of the Pacific oyster Crassostrea gigas during the first 48 hr after fertilization. Larvae were produced by induced spawning of mature oysters. They were then subjected for 48 hr to concentrations of radionuclides ranging from 10^{-8} to 10^{-2} Ci/liter. Because some of the ^{65}Zn and ^{51}Cr experimental lots contained either carrier zinc or chromium, the toxic effect of these two stable elements was determined by use of a carrier-free ^{65}Zn solution and by experiments with stable zinc and chromium in the chloride form. After 48 hr the experiments were terminated, and the percentage of abnormal larvae in each lot was determined. Abnormal larvae were defined as those larvae which had incompletely developed shells. The results indicate that significant increases in abnormal oyster larvae were present in ^{65}Zn concentrations of 10^{-4} Ci/liter and greater and that the effects of $^{90}Sr + ^{90}Y$ and ^{51}Cr began at 10^{-3} Ci/liter. Stable zinc in the form of zinc chloride had a toxic effect at concentrations of 7×10^{-1} mg Zn/liter and greater, whereas chromium chloride had no effect at any of the levels tested. The concentrations required to produce abnormal oyster larvae are more than a million times greater than the concentration of these radionuclides that have been found in natural environments. (auth)

12377 COMPARATIVE ASSESSMENT OF THE TOXICITY OF DDT AND URANIUM FOR THE INTACT ANIMALS AND

THOSE WITH EXPERIMENTAL HEPATITIS AND NEPHRITIS. Arsen'eva, M. V. (Moscow Medical Inst.). Gig. Sanit.; No. 10, 27-30(Oct 1972). (In Russian).

In acute, subacute, and chronic experiments undertaken, no significant difference could be noted in the reaction of intact animals and those with model sicknesses to the introduction of the toxic substances in equal doses. (auth)

12378 INEFFECTIVENESS OF GLUCAN ALONE AND IN COMBINATION WITH DTPA IN ACCELERATING EXCRETION OF ^{144}Ce IN RATS. Trnovec, T.; Pleskova, A.; Chorvat, D.; Kollar, J. Prac. Lek.; 24: No. 8, 298-301(Oct 1972). (In Slovak).

Stimulation of the reticuloendothelial system in rats by repeated application of glucan at a dose of 1 mg/100 g weight on the 2nd to 6th day after ^{144}Ce administration in ionic or colloidal state, intravenously or intratracheally, was of no effect upon organ distribution of ^{144}Ce on the 9th day and on its excretion. At the same time glucan did not influence the effect of DTPA upon metabolism of ^{144}Ce. DTPA was administered intraperitoneally at a dose of 100 μm/100 g weight on the 2nd, 4th, and 6th day of the experiment. (auth)

12379 METABOLISM OF COMPOUNDS OF PLUTONIUM AND OTHER ACTINIDES. A Report Prepared by a Task Group of Committee 2 of the International Commission on Radiological Protection. New York; Pergamon Press (1972). 65p. (ICRP-19).

The report deals with the subject in sections: the chemistry of plutonium and related elements, with special reference to their biological behaviour (hydrolysis, polymerization, and complex ion formation, interactions with molecules of biological importance); entry of plutonium by inhalation (partition in the respiratory tract, retention as a function of compound class, early clearance, long-term clearance, translocation from the lung, pathological consequences of plutonium inhalation); the absorption of plutonium and related elements from the gastrointestinal tract; absorption of plutonium and related elements through the intact skin; entry by injection, punctures, or other wounds: tissue distribution of absorbed nuclides (intravenous administration, effect of colloidal or polymeric state, effect of valence, effect of stable, non-metabolizable chelating agents, effect of radionuclide mass, intramuscular administration, intradermal or subcutaneous administration, subcellular distribution, translocation of actinides to secondary deposition sites); retention of deposited actinides (tissue retention after a single introduction—skeleton, bone marrow, liver, miscellaneous soft tissues; tissue retention after continuing introduction from a local deposit—depletion rates of plutonium from skeleton and liver of man, possible carcinogenic implications for man). Tables are included on the following topics: amended constants for use with Task Group Lung Model clearance model, summary of principal inhalation studies with Pu compounds in experimental animals, the absorption of Am, Np, Pu, and Th from the gastrointestinal tract, distribution of actinide compounds after intravenous injection, absorption and distribution of actinide compounds after intramuscular injection, distribution of Pu after intradermal or subcutaneous injection, retention of deposited actinides. An extensive list of references is included. (UK)

Plants

12380 (CEA-CONF-2091) EFFECT OF AGRICULTURAL TECHNOLOGY ON THE RADIOACTIVE CONTAMINATION OF FOOD PRODUCTS. Bovard, P.; Delmas, J.; Grauby, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 15p. (In French). (CONF-720960-2). Dep. NTIS (U. S. Sales Only).

From International symposium on chemical engineering in the service of mankind; Paris, France (3 Sep 1972).

Rice, potatoes, spinach, beans, tomatoes, and grapes grown in the Bas-Rhone Languedoc region were contaminated with ^{90}Sr and ^{137}Cs during irrigation. The effects of mechanically refining the rice, cooking the potatoes, spinach, beans, and tomatoes, and the production of fruit juices, tomato concentrates, and wines on the level of contamination in the product consumed were studied. The contamination of products collected from the aerial part and the other parts of the plant was studied. (France)

New Tracer Techniques

12381 (COO-119-247) ^{83}Rb AND ^{137}Cs METABOLISM IN PERSONS AFFECTED BY MUSCLE DISEASE. Lloyd, R. D.; Mays, C. W.; McFarland, S. S.; Zundel, W. S.; Tyler, F. H. (Utah Univ., Salt Lake City. Radiobiology Div.). Oct 1972. Contract AT(11-1)-119. 72p. Dep. NTIS.

Since normal muscle tissue can incorporate rubidium and cesium ions, a double tracer of the gamma-emitting radionuclides ^{83}Rb + ^{137}Cs was administered orally to normal humans, female genetic carriers of Duchenne muscular dystrophy, boys with Duchenne dystrophy, and additional subjects, ages 12 to 61, who were affected by different forms of muscular dystrophy or by other muscle disease. Radioactivity in the blood, in excreta, and in the total body was determined by gamma counting. The retention of ^{83}Rb measured in the body for about 6 months after administration and that of ^{137}Cs for about 12 months after administration was found to be a function of age and sex in healthy persons. Retention of ^{83}Rb and especially ^{137}Cs by subjects with advanced muscle disease was generally much lower than in control subjects of corresponding age and sex. The degree of difference appeared to depend upon the severity of the disease. (CH)

12382 NEW RADIOACTIVE TRACER METHOD FOR AUTOMATIC CONTINUOUS MONITORING OF THE RATE OF HEMODIALYSIS. Waters, J. R. (Johnston Labs., Inc., Cockeysville, MD). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 252-6(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

The progress of hemodialysis is monitored by selecting a glomerular substance, such as DTPA, that is removed by the artificial kidney at a realistic rate and labelling it with a radioisotope, preferably ^{99m}Tc, that gives a low patient radiation dose and is easy to measure. The ^{99m}Tc-DTPA is injected intravenously and allowed to equilibrate in the patient. Hemodialysis is then started with a conventional dialyzer. The isotope concentration is measured with a simple scintillation counter, 3 or 4 turns of the blood-filled plastic tubing between the patient and dialyzer being wrapped around the detector crystal. The counting rate is a measure of the fraction of ^{99m}Tc-DTPA remaining in the patient. The drop in counting rate due to the radioactive decay of the isotope is automatically compensated by a novel ratemeter whose sensitivity increases with time at the appropriate exponential rate. Its output indicator is set to 100% at the start of dialysis and decreases as the isotope is removed, being about 35% after 6 hours. By watching the meter the dialysis may be terminated at any desired level. Thirteen patients have been studied with good results. This technique is simple to use and presents no contamination or radiation hazard to the patient. It has potential clinical application for hospital and home dialysis of patients with chronic kidney failure. (6 figures) (auth)

12383 RADIOIMMUNOASSAY FOR alpha$_1$-FETOPROTEIN IN THE SERUM OF RATS. Oakes, D. D.; Shuster, J.; Gold, P. (McGill Univ., Montreal). Cancer Res.; 32: No. 12, 2753-60 (Dec 1972).

A radioimmunoassay for the detection of α_1-fetoprotein (AFP) in the sera of rats is described. The procedure is based on the preparation of purified and radiolabeled AFP, monospecific anti-AFP antiserum, and a modification of the coprecipitation-inhibition technique in 50% saturated ammonium sulfate. A detailed description is given of the combination of immunochemical and physiocochemical methods used in the purification of the rat AFP. The purified rat AFP is virtually identical to the native, circulating AFP by immunological criteria and contains, at most, trace contamination with other materials. The radioimmunoassay has a sensitivity that allows 25 ng AFP per ml of serum to be detected with reproducibility. The assay requires 20 μl of serum for analysis and can be completed within a few hours. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 11680, 11718, 11916, 11921, 12441, 12442, 12445, 12485, 12492, 12987, 13830, 13871, 13915, 14290, and 14309.

12384 (AERE-R-6830) THERMAL DIFFUSION PHENOMENA IN NON-STOICHIOMETRIC OXIDE FUELS. PART I. EVIDENCE OF GAS PHASE OXYGEN TRANSPORT IN UO_{2+x} FROM AXIAL AND RADIAL TEMPERATURE-GRADIENT EXPERIMENTS. Adamson, M. G.; Carney, R. F. A. (Atomic Energy Research Establishment, Harwell (England)). Oct 1972. 42p. Dep. NTIS (U. S. Sales Only). UK 1.00 pounds.

Results of experiments in which sintered pellets of hypostoichiometric urania (O/U = 2.035 to 2.045) were subjected to longitudinal (axial) temperature gradients of 750 to 1550°C in sealed platinum and platinum–rhodium capsules and radial temperature gradients of 1000 to 2025°C in localized inert gas/CO–CO_2 atmospheres, show that in the presence of the unavoidable impurity carbon, even at levels as low as 3 ppM, a gradient in O/U is produced by migration of oxygen to the hottest regions of the material. When the maximum temperature is less than 1600°C the oxygen migration takes place almost exclusively through the CO + CO_2 gas generated by reaction between UO_{2+x} and the carbon impurity, i.e., according to the Markin–Rand–Roberts hypothesis. At higher maximum temperatures there is evidence of a significant contribution from a UO_3 distillation path to the overall thermal diffusion process. An irreversible thermodynamics treatment of the results yielded heats of transport of ca –30 kcal/mole for the axial gradient experiments and ca –15 kcal/mole for the radial gradient experiments. Factors such as experimental arrangement and thermo-EMF's are not believed to contribute to this difference. A novel EMF multiprobe technique was applied for the nondestructive determination of $\Delta\bar{G}_{O_2}$ (and O/U) as a function of radius in the center-heated UO_{2+x} specimens. (auth)

12385 (AERE-R-6831) THERMAL DIFFUSION PHENOMENA IN NON-STOICHIOMETRIC OXIDE FUELS. PART II. OXYGEN REDISTRIBUTION IN HYPERSTOICHIOMETRIC URANIA–PLUTONIA. RESULTS OF AXIAL TEMPERATURE-GRADIENT EXPERIMENTS. Adamson, M. G.; Carney, R. F. A. (Atomic Energy Research Establishment, Harwell (England)). Oct 1972. 15p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Platinum, 20% rhodium capsules containing $U_{0.85}Pu_{0.15}O_{2+x}$ pellets were subjected to axial thermal gradients with temperatures ranging from 800 to 1580°C for periods varying from 48 to 195 hours. Experiments were performed at the following O/M ratios: 2.060 ± .005, 2.050 ± .005, 2.020 ± .003 and 2.002 ± .001, and in each case a gradient in the O/M ratio was produced by migration of oxygen to the hottest region of the material. This direction of transfer is in agreement with predictions of the Markin–Rand–Roberts CO/CO_2 hypothesis but the heats of transport derived from these data appear to depend on overall O/M and also differ from Aitken's predicted value. In attempting to explain these discrepancies some unexpected features in the high temperature thermodynamics of $U_{1-y}Pu_yO_{2+x}$ are revealed. (auth)

12386 (ANL-7922) CHEMICAL ENGINEERING DIVISION, FUELS AND MATERIALS CHEMISTRY SEMIANNUAL REPORT, JANUARY–JUNE 1972. Chasanov, M. G.; Johnson, C. E.; Battles, J. E.; (and others) (Argonne National Lab., Ill.). Oct 1972. Contract W-31-109-Eng-38. 60p. Dep. NTIS.

Two sections are included; a separate abstract was prepared for each. (PCH)

For abstracts of individual sections see: 11679 and 12387.

12387 (ANL-7922, pp 10-28) MATERIALS CHEMISTRY AND THERMODYNAMICS. Oct 1972.

In Chemical Engineering Division, fuels and materials chemistry semiannual report, January–June 1972.

To aid in evaluating the performance of fast-breeder reactor fuels, high-temperature studies are being made of the U–Pu–O–Na, U–Nd–O, U–Ce–O, and U–Mo–O systems, and modeling studies of oxygen potentials over oxide fuels are being performed. Studies of the oxygen/metal composition of uranium-plutonium mixed oxides in equilibrium with sodium and Na_3MO_4, where M = Pu_yU_{1-y}, were extended to a Pu/(Pu + U) ratio of 0.1 for temperatures of 600 to 900°C. Kinetic studies of the reaction of sodium with sintered mixed-oxide pellets are reported. Oxygen potentials over $U_{0.9}Ce_{0.1}O_x$, $U_{0.95}Ce_{0.05}O_x$, and $U_{0.9}Nd_{0.1}O_x$ are reported. Studies of the activities of MoO_2 over urania-MoO_2 mixtures are presented. A model for calculation of oxygen pressures over $UO_{2\pm x}$ is presented and comparisons with experiments are given; the agreement between calculated and experimental values is excellent. (auth)

12388 (ANL-Trans-923) FISSION PRODUCT DISTRIBUTION AND LOCALIZATION BY GAMMA-SPECTROMETRY DURING AND AFTER IRRADIATION. de Contenson, Ghislain; Monier, Jean; Vignesoult, Nicole. Translated for Argonne National Lab., Ill., from Paper 9C of Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7–11 August 1972. 16p. (CONF-720843-11). Dep. NTIS.

Gamma-spectrometry permits the identification and scoring of γ-emitting radioactive atoms; it is used during and after irradiation for the determination of the longitudinal and radial fission product distributions. The studies during irradiation are made directly through the irradiation device after each reactor cycle or, in the case of an incident, immediately after the unloading operation. These analyses permit a detection of the collection of fission products accompanying mass transport, for example, in the case of fuel which has melted in the core. The studies after irradiation made in the hot cell are performed longitudinally and transversely in the pins—primarily a destructive study, and radially, on micrographic sections. These fine-structure analyses permit a localization of the fission products at the end of irradiation in the UO_2 as well as in the fuel element structures. Examples of fission product localization are presented in the case of an oxide which underwent partial melt-down. (auth)

12389 (ANL-Trans-924) MICROPROBE ANALYSIS OF METALLIC FISSION PRODUCTS IN FUELS IN ORDINARY WATER GEOMETRY OPERATING WITH A MOLTEN ZONE. Bazin, Jean; Perrot, Michel; Vignesoult, Nicole. Translated for Argonne National Lab., Ill., from Paper 9D of Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7–11 August 1972. 14p. (CONF-720843-10). Dep. NTIS.

The distribution of metallic fission products was studied in experimental fuel elements in a light water geometry (UO_2 clad with Zircaloy). These fuel elements operated up to burnups of between 30,000 and 60,000 MWd/t U with a limited molten zone present continuously. These fuel elements were subjected either to rapid or to slow decay cooling. The microprobe analyses covered the following: qualitative and quantitative composition of precipitated fission products (globular fission products, lingots collected in the central channels, "gray phases"), and radial distribution of fission products dissolved in the UO_2 matrix, primarily zirconium. A correlation was made between the results of these analyses and the patterns observed in metallography (microscopy, autoradiography). (auth)

12390 (ANL-Trans-925) THERMODYNAMIC PROPERTIES AND DIAGRAM OF THE SYSTEM U–Nd–O. Wadier, J. F.; Marcon, J. P.; Pesme, O. Translated for Argonne National Lab., Ill., from Paper 9E of Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7–11 August 1972. 7p. (CONF-720843-14). Dep. NTIS.

The ternary system of U–Nd–O was studied at 850°C. The phase diagram, variations of the crystal parameter of the fcc phase, and the thermodynamic properties were determined by equilibrium in the presence of a CO/CO_2 gas phase on the thermobalance. The phase diagram was characterized by a large domain of the fcc phase. A thermogravimetry study at 850°C showed a sharp discontinuity of the partial free molar enthalpy of oxygen ΔG_{O_2} for Nd concentrations of 20, 30, and 40% with the ratio O/U + Nd = 2.00. This phenomenon cannot be explained by a change of valence of U. However, it may be interpreted on the basis of crystallographic reasoning. (P.C.H.)

12391 (ANL-Trans-926) REACTION AT THE INTERFACE OF CLADDING (STAINLESS STEEL) AND FUEL (MIXED OXIDE [U,Pu]O_{2+x}) IN FUEL ELEMENTS IRRADIATED BY FAST NEUTRONS. Calais, D.; Conte, M.; de Keroulas, F.; LeBeuze, R. Translated for Argonne National Lab., Ill., from Paper 17 of Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7–11 August 1972. 15p. (CONF-720843-12). Dep. NTIS.

Chemical reactions at clad–fuel interface are examined. Results show that the volatile fission products such as tellurium and cesium iodides can play an important role in the development of the oxide-cladding reaction observed in fast reactor fuel elements because of their chromium-impoverishing action on the steel (direct action and gas-phase transport phenomena of the Van Arkel type). It is also believed that the deviation from stoichiom-

etry of the fuel is an important parameter. Moreover, it is probable that the temperature in the interior of the cladding and the acceleration of diffusion under irradiation are of great influence. The reaction mechanism presented is only a guideline scheme. It is probable that the phenomena are much more complex. Fuller analysis is necessary to solve this problem completely. (auth)

12392 (ANL-Trans-927) DEMONSTRATION OF OXYGEN MIGRATION DURING IRRADIATION : IRRADIATION L-1. Trotabas, M.; de Keroulas, F.; Gatesoupe, J. P. Translated for Argonne National Lab., Ill., from Paper 19A of Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7-11 August 1972. 12p. (CONF-720843-9). Dep. NTIS.

The object of irradiation L-1 was to attempt to demonstrate the radial distribution of oxygen under the influence of thermal gradients during irradiation and to verify the validity of proposed models. In spite of the difficulties encountered in taking samples as a function of radius and their large size (diameter of ≃1 mm), the migration of oxygen during irradiation was verified. The trend observed was that predicted by Rand and Markin, but the absolute values were smaller than those reported. In the case of highly substoichiometric oxides, it is believed that the model proposed by Aitken represents the observed phenomenon rather well. In contrast, in the case of superstoichiometric oxides it becomes necessary to take vaporization-condensation phenomena beyond 2000°C into account. It is also necessary to point out that the method for measuring the O/U + Pu ratio from the value of the lattice parameter is relatively inaccurate and may explain the differences compared to the theoretical models. This is particularly true in the case of superstoichiometric oxides in which the variation of the lattice parameter as a function of oxygen content is small. It would thus be advisable for the future to make direct measurements of smaller specimens by thermogravimetry. (auth)

12393 (ANL-Trans-928) THERMAL DIFFUSION AND VAPORIZATION IN IRRADIATED MIXED OXIDES VARIATION OF THE RATIO Pu/U+Pu. Mouchnino, M. Translated for Argonne National Lab., Ill., from Paper 19B of Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7-11 August 1972. 14p. (CONF-720843-7). Dep. NTIS.

Measurements of the Pu/U + Pu ratio demonstrate three mechanisms of plutonium transport in the irradiated oxides. Only thermal diffusion calculations were performed in full. They permitted a quantitative description of the experimental curve obtained with one of the specimens. Qualitatively, the following was observed on the other specimens: a pure vaporization effect; simultaneous vaporization and thermal diffusion effects; and melting effect. In the future, fast-neutron irradiation and a more accurate knowledge of the vapor phases above the irradiated oxides should permit better information to be obtained concerning the various plutonium redistribution processes. (auth)

12394 (BNWL-tr-81) RECOVERY PROCESSES IN OXYGEN SUBLATTICES OF QUENCHED AND NEUTRON-IRRADIATED URANIUM DIOXIDE. Vollath, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translated for Battelle Pacific Northwest Labs., Richland, Wash., from report KFK-1621. 39p. Dep. NTIS.

Recovery processes occurring in quenched and neutron-irradiated uranium dioxide in the temperature region between room temperature and 500°C are due to the migration of defects in the oxygen sublattice. Migration of uranium defects was not observed. Oxygen Frenkel defects were annealed at temperatures of about 400°C. This recovery step was found to be independent of specimen stoichiometry for irradiated and quenched samples. Recovery processes which were found in the temperature region between 150 and 250°C were characteristic for hyperstoichiometric material. (auth)

12395 (CEA-CONF-2062) THERMAL DIFFUSIVITY OF URANIUM OXIDE AND THORIUM OXIDE AT HIGH TEMPERATURE. Weilbacher, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 20p. (In French). (CONF-720661-2). Dep. NTIS (U. S. Sales Only).

From third European conference on thermophysical properties of solids at high temperatures; Turin, Italy (20 Jun 1972).

The thermal diffusivity of samples of mono- and polycrystalline UO_2 (98% theoretical density) and of polycrystalline ThO_2 (97.3% theoretical density) was measured. The results obtained were compared with those obtained in other laboratories on samples of the same density. The thermal conductivity of the samples was calculated. The results were interpreted. (tr-auth)

12396 (CONF-720662-2) FAST REACTOR FUEL MANUFACTURE. Kent, W. C. L.; Davidson, A. S. (British Nuclear Fuels Ltd., Risley (England)). 1972. 12p. Dep. NTIS (U. S. Sales Only).

From Seminar on nuclear energy; Barcelona, Spain (6 Jun 1972).

In the manufacture of fast reactor fuels, the highly toxic nature and radiation hazards of Pu make high plant reliability and the efficiency and proven stability of the manufacturing route extremely important. A detailed appraisal is given of the problems arising and the philosophy of the engineering solutions adapted to overcome them. Important differences between large scale manufacture of Pu and U fuels are brought out. (UK)

12397 (GERHTR-10) INVESTIGATION AND PRODUCTION OF SPHERICAL DOPED UO_2 FUEL PARTICLES. A CONTRIBUTION TO THE CLARIFICATION OF THE RETAINING CAPACITY OF COATED PARTICLES FOR SOLID FISSION PRODUCTS. Hamesch, Muwaffak (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Feb 1971. 139p. (JUL-730-RW). Dep. NTIS.

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

Methods for the incorporation of a number of solid fission products in spherical UO_2 kernels, based on the sol-gel process, were developed, and the effects of kernel composition on the release of solid fission products were subsequently determined by means of oxide additives. Three known sol-gel processes were tested, and the methods and apparatus developed for execution of the experiments are described. Characterization of the model kernels obtained was effected by chemical and γ-spectrometric analysis, by metallographic and microprobe investigations, and also by measurement on the lattice constants. The results in regard to the dependence of fission product release on core composition, temperature, and annealing time showed that the release of the fission products Ba and Sr from the doped kernels was proportional to the annealing time and annealing temperature. Kernels, containing Nb or Al in addition to the fission products Ba or Sr, exhibited lower fission product losses in comparison with the kernels having no oxide additive. The model kernels were then coated with pyrolytic carbon by means of propene pyrolysis and subjected to long-time annealing for 500 h at 1000, 1200, and 1550°C. The fission product release of model particles, which were doped only with Ba or Sr, rose in this case also with an increase in temperature. The coated particles with an Al_2O_3 or Nb_2O_5 additive exhibited no fission product losses. (P.C.H.)

12398 (NRCN-281) DEVELOPING CERAMIC FUEL FOR ATOMIC REACTORS, PREPARATION, AND PROPERTIES OF REFRACTORY URANIUM OXIDE. Hadari, Z.; Vaknin, S. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). Feb 1972. 40p. (In Hebrew). INIS.

The parameters for producing refractory uranium dioxide were examined. A method for preparing high-quality UO_2 capsules, which meets fuel requirement in atomic reactors was developed. The preparation method of UO_2 and its correlation to the physical, chemical, and mechanical properties of the final product is discussed. (INIS)

12399 (ORNL-TM-3978) PROCESS REQUIREMENTS FOR PREPARING ThO_2 SPHERES BY THE ORNL SOL-GEL PROCESS. Haas, P. A. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 38p. Dep. NTIS.

Process requirements are given for the preparation of ThO_2 spheres by the use of ORNL sol-gel processes. The hydrothermal denitration of thorium nitrate to yield a dispersible ThO_2 powder has three critical requirements that can be satisfied by batch operation in a rotating stainless steel drum reactor. Stable 2.5 M ThO_2 sols are prepared by agitation of the ThO_2 powder with the optimum amount of dilute, hot nitric acid. Conditions have been improved for recycle of the 2-ethyl-1-hexanol medium for forming ThO_2 gel spheres. The optimum drying-firing conditions require argon to a temperature of 110°C and then argon-steam to at least 220°C, followed by firing in air to 1150°C. (auth)

12400 (SLA-73-24) METHOD OF OBTAINING NIOBIUM-CARBIDE POWDER AND COATINGS FROM THE GAS-VAPOR PHASE. Lyudvinskaya, T. A.; Sinel'nikova, V. S.; Kosolapova, T. Ya.; Sergeev, V. P. Translated by G. V. Samsonov (Sandia Labs., Albuquerque, NM), from pp 28-32 of Tugoplavkie Karbidy, Naukova Dumka, Kiev, 1970. 10p. Dep. NTIS.

Preparation of NbC by reduction of mixtures of $NbCl_5$ and CCl_4 using H was investigated. The rate of carbide deposition was studied as a function of reactant concentration, substrate temperature and H feed rate. It was found that the optimal ratio of H to the sum of the chlorides is 10 to 1. Data are included on parameters of carbide deposition, and chemical composition and on results of NbC spectroscopic analyses. (JRD)

12401 (TP-375) KINETICS OF VOID GROWTH DURING NEUTRON IRRADIATION. Bullough, R. (Atomic Energy Research Establishment, Harwell (England)). Aug 1969. 10p. Dep. NTIS (U. S. Sales Only).

The growth kinetics of the voids in solids is discussed using a model proposed to derive a growth rate equation. This growth rate equation contains only the "excess" vacancy concentration and no attempt is made to include quantitatively the effects of the presence of interstitials, although it is noted that for void growth to occur it is necessary to remove the interstitials preferentially from the system and thereby maintain an excess concentration of vacancies in the neighborhood of the voids. Development of the model is described incorporating a void growth treatment that explicitly includes migrating species and demonstrates that when a preferential sink is provided for the interstitials, void growth occurs. An analytic form for the asymptotic swelling behavior is obtained. A description of the surface step model for the void surface is included. (JRD)

12402 KINETIC FEATURES OF THE CARBOTHERMAL PRODUCTION OF MIXED CARBIDES OF URANIUM AND NIOBIUM. Kiselev, V. A.; Vlasov, V. G.; Danchenko, N. M. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 106-8(1972). (In Russian).

The preparation of mixed uranium and niobium carbides is described. UO_2, metallic Nb, and acetylene (carbon) black are mixed and heated in a vacuum furnace to 1,700 to 1,950°K. The mixture begins to react at temperatures over 1,500°K, the activation energy is 38 to 57 kcal/mole. The role of the vaporized oxides is thought to drive the reaction to completion. Solid solutions of UC and NbC constitute the chief end-product. (K.S.W.)

12403 PHASE EQUILIBRIA IN THE NIOBIUM ANGLE OF THE Nb-Zr-C AND Nb-Ti-C SYSTEMS. Druzhinin, I. I.; Zakharov, A. M.; Novikov, I. I. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 118-21(1972). (In Russian).

Two ternary metal systems containing Nb and C were investigated at 1800 and 2100°C in the Nb corner of the ternary diagram. The Nb-Zr-C system was studied within the limits 0.028 to 1.97% C and 0.56 to 18.5% Zr. X-ray analyses showed α + (Nb,Zr)C for all compositions except the lowest (1.5%) Zr which contained α + Nb_2C. The Nb-Ti-C system was studied within the limits 0.018 to 2.39% C and 0.24 to 13.2% Ti. Microstructure studies showed the same features as in the first ternary alloy. The solubility of Nb_2C in both ternaries is contrasted. (K.S.W.)

12404 ROLE OF THE GRAIN BOUNDARY OF CERAMIC OXIDES IN THEIR INTERACTION WITH METAL-PLATED COATINGS. Demyantsevich, V. P.; Konnikov, S. G.; Popov, V. F.; Sapronova, N. A. Fiz. Khim. Obrab. Mater.; No. 2, 51-6(1972). (In Russian).

The role of grain boundaries in Al_2O_3 materials which lack a vitreous phase was studied with regard to their reaction with metal coatings formed by high-temperature brazing. This reaction was observed to occur chiefly along grain boundaries forming solid solutions with corundum. This process was practically independent of the ceramic structure as chemical compounds were formed in the contact layer. The microstructure of the ceramic composition Mo-15% TiO_2 failed to reveal any sort of transitional layer different from corundum. (tr-auth)

12405 SINTERING OF COBALT AND ITS ALLOYS CONTAINING 10 PERCENT CARBIDES. Jung, O.; Kohlhaas, E.; Peter, W.; Dawihl, W. Cobalt (Engl. Ed.); No. 53, 214-22(Dec 1971).

With a view to elucidating the role of Co as a binder in hard metals the sintering behavior of Co and Co + 10% carbides also WC, TiC, WC-50% TiC, and WC-29% TiC-26% TaC were studied. The effectiveness of the sintering process was related to reactions such as desorption of the O adsorbed on the grains, reduction of the Co oxides, dissolution of the carbides into the Co phase, and allotropic transformation, and recovery and recrystallization of the binder. The extent to which these phenomena occur was studied from room temperature to 1200°C, complete recrystallization of the Co phase being observed at the highest sintering temperature. Among the carbide-forming elements studied, W had greatest solubility and Ti the lowest. (Metals Abstr.)

12406 REDOX POTENTIAL OF THE ENVIRONMENT IN A VERNEUIL FURNACE. Bazhenova, I. L.; Zeligman, E. B.; Shorin, S. N. (Inst. of Chemical Engineering, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 6, 869-73(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 6, 993-8(Jun 1972).

A method of estimating the redox potential of the combustion products of hydrogen in oxygen, in relation to certain oxides, from the partial pressure of oxygen in the thermal dissociation products of these oxides is described. The results of the analysis show that for most oxides an atmosphere of the combustion products of hydrogen in oxygen, with $\alpha = V_{H_2}/V_{O_2}$ between 1.0 and 3.0 is oxidative. A method of reducing the concentration of reducing agent in the reaction products of combustion of H_2 with O_2 by adding a small amount of an inert gas is suggested. (auth)

12407 THERMODYNAMIC DATA FOR SOME URANIUM OXIDES WITH NONSTOICHIOMETRIC COMPOSITIONS. Marchidan, D. I.; Matei, S. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 17: No. 9, 1487-91(Sep 1972).

Electromotive force measurements on high-temperature galvanic cells containing a solid electrolyte were made in order to obtain thermodynamic data for some uranium oxides, which within certain temperature ranges are disproportionated in two phases. Partial molar free energies, enthalpies, and entropies of solution of oxygen in uranium oxides and the corresponding relative integral quantities as a function of the temperature, as well as the equilibrium pressures of oxygen over the two oxides, were calculated. (auth)

12408 X-RAY INVESTIGATION OF THE TERNARY SYSTEMS RHENIUM-ALUMINUM-BORON AND RHENIUM-SILICON-BORON. Chaban, N. F.; Kuz'ma, Yu. B. (Lvov State Univ.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 6, 933-6(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 6, 1065-8(Jun 1972).

Using x-ray structural analysis, parts of the systems Re-Al-B and Re-Si-B were investigated, and phase diagrams were constructed. The formation of a ternary compound of the composition Re_3Al_2B with a structure of the Mn_3Ni_2Si type (a = 10.835 ± 0.01 Å) was established. (auth)

12409 MECHANISM OF SEPARATION OF CARBIDES IN MOLYBDENUM AND NIOBIUM ALLOYS. Shulepov, V. I.; Yudkovskii, S. I.; Akif'ev, S. K.; (and others). Fiz. Khim. Obrab. Mater.; No. 2, 126-31(1972). (In Russian).

The mechanism of separation (segregation) of Mo_2C and TiC was studied in Mo alloys, and that of Nb_2C and Zr(Nb)C was studied in Nb alloys. The existence of these or other carbides in different temperature regions was not determined by the thermodynamic stability of the carbides, but by the thermodynamics and kinetics of their formation in the breakdown of a solid solution. A separation scheme for carbides in Mo and Nb alloys is proposed. (tr-auth)

12410 MICROHARDNESS AND THERMAL EXPANSION OF TRANSITION METAL NITRIDES AT 80 TO 300°K. Timofeeva, I. I.; Shvedova, L. K. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 6, 1027-9(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 6, 1169-70(Jun 1972).

The microhardness and thermal expansion coefficient of the nitrides of Ti, Zr, Hf, V, Nb, and Ta were measured at 80 to 300°K. Results are presented tabularly. (J.R.D.)

12411 SYSTEM Cr-Ni-B. Chepiga, M. V.; Krivutskii, V. P.; Kuz'ma, Yu. B. (Lvov State Univ.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 6, 928-32(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 6, 1059-64(Jun 1972).

Using x-ray phase and microstructural analyses, the system Cr-Ni-B was investigated and the isothermal cross section at 800°C was constructed. The existence of two ternary compounds: Cr_3NiB_6 (orthorhombic structure of the V_2B_3 type, a = 3.034 ± 0.003 Å; b = 18.11 ± 0.02 Å; c = 2.956 ± 0.003 Å) and $Cr_2Ni_3B_6$ (orthorhombic structure of the V_5B_6 type, a = 2.971 ± 0.003 Å; b = 20.34 ± 0.002 Å; c = 3.011 ± 0.003 Å) was established. (auth)

12412 THIN FILMS OF THE SYSTEM In-Te. Paukshte, Yu. A.; Vesene, T. B.; Tolutis, V. B. (Inst. of the Physics of Semiconductors, Riga). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 6, 901-5(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 6, 1029-34(Jun 1972).

Thin films of the system In-Te containing 33 to 45 at. % Te were investigated. It is shown that this region contains only one phase; this contains 40 ± 1.2 at. % Te, which coincides with reasonable accuracy with the composition of the compound In_3Te_2. The morphology, microstructure, and physical properties of crystalline In_3Te_2 films have been investigated. It has been established that In_3Te_2 is an anisotropic semiconductor with a forbidden-zone width (disregarding anisotropy) of ~0.48 eV at 18°C. (auth)

12413 VAPORIZATION THERMODYNAMICS OF THE RARE EARTH BORIDES. McGrath, L. C. University Park, NM; New Mexico State Univ. (1972). 236p. University Microfilms Order No. 72-31,646.

Thesis.

The vaporization reactions of most of the rare earth borides were determined using a Bendix time-of-flight mass spectrometer and Knudsen cell effusion technique. In addition to determining how the rare earth borides thermally decomposed, heats of reaction and heats of formation were also calculated for most of the rare earth tetra- and hexaborides. For the rare earth tetraborides, these compounds were observed to decompose in two different ways, either congruently $MB_4 = M(g) + 4B(g)$ or incongruently $3MB_4 = 2MB_6 + M(g)$. For the rare earth hexaborides, three distinctly different decomposition patterns were observed as follows: $MB_6 = M(g) + 6B(g)$, $MB_6 = MB_4 + 2B(g)$, and $YbB_6 = YbB_{100} + Yb(g)$. In addition to the tetra- and hexaborides, the decomposition pathways for Tb, Er, Ho and Tm dodecaborides were determined. In the case of Tb, Er and Ho, these dodecarborides decomposed incongruently: $MB_{12} = MB_6 + 6B(g)$ while TmB_{12} decomposed congruently: $TmB_{12} = Tm(g) + 12B(g)$. Although there are seven different decomposition pathways observed for the rare earth borides, all of the reactions are dependent upon one another and their mutual interdependence can be accounted for. The correlation of the observed decomposition reactions was rationalized on the basis of the size of the rare earth metal. Each rare earth boride (MG_4, MB_6, or MB_{12}) appears to have upper and lower limits on the size of the metal atom that can be accommodated within the particular boron framework. The limits imposed on the size of the metal atom are a result of the extreme rigidity of the boron framework found in all three boride phases. Since the boron framework is so extremely rigid, small differences in the size of the metal atom produce large differences in the stability of the boride; hence, for a given rare earth metal the ability of forming a tetraboride vs a hexaboride or dodecaboride will be directly related to its size. (Diss. Abstr. Int., B)

12414 CREEP OF TUNGSTEN DISPERSION STRENGTHENED BY ZrO_2. Blickensderfer, R. Corvallis, OR; Oregon State Univ. (1972). 94p. University Microfilms Order No. 72-27,621.

Thesis.

Tungsten alloys containing approximately 0.75 and 2.3 vol % ZrO_2 were prepared by powder metallurgical methods from blends of commercial tungsten powder and ZrW_2 powder. A heat treatment of the extruded rods at 1800°C was found to produce a stable structure with a dispersion of ZrO_2 particles in the tungsten matrix. The mean particle size was about 0.2 μm, the mean particle spacing about 2 μm, and the mean tungsten grain size about 7μm. There was essentially no difference in microstructure between the two alloys except the 2.3 vol % ZrO_2 alloy contained more of the coarse ZrO_2 stringers. The tensile strength of the alloys ranged from 45 ksi at 1500°C to 25 ksi at 2000°C. Stress rupture lives were determined at 1375 and 1740°C over a stress range of 10 to 60 ksi. Creep measurements were made over the temperature range of 1465 to 1924°C and over a stress range of 3.5 to 20 ksi. The activation energy for creep was found to be a constant 104,200 ± 3,200 cal per g mole °K over the entire range of stress and over the temperature range of 1500 to 1800°C. The activation volume was calculated as 1.3×10^{-21} cm^3. The creep rate was found to vary linearly with stress in the low stress region ($\sigma <$ 12 ksi), and to vary as stress to the power of 4.6 in the high stress region ($\sigma >$ 14 ksi). The creep behavior of these tungsten alloys fits the functional relationships of stress and temperature given by the Ansell–Weertman model for dispersion strengthened alloys at both low and high stresses. However, the values of creep rate calculated from the model were about 10^3 times greater than the experimental values. The Nabarro–Herring creep model fits the creep behavior of the tungsten alloys at low stresses both with respect to the functional dependence and the values of creep rate. A modification of the Ansell–Weertman model in the high stress region was made in which the area swept out by a dislocation corresponding to a unit of climb is taken as of the order of λ^2 where λ is the planar interparticle spacing. The density of active Frank–Read sources was taken as 10^9 per cm^3. This modified Ansell–Weertman model was found to satisfy the stress and temperature relationships for creep of the tungsten alloys and to give values of creep rate which agree very well with experimental results. The modified model was also found to provide the correction of 10^4 needed to satisfy earlier experimental results on dispersion strengthened aluminum. (Diss. Abstr. Int., B)

12415 STUDY OF THE STRENGTH OF TUNGSTEN CARBIDE–COBALT ALLOYS FROM A FRACTURE MECHANICS VIEWPOINT. Lueth, R. C. East Lansing, MI; Michigan State Univ. (1972). 164p. University Microfilms Order No. 72-29,996.

Thesis.

The critical strain energy release rate and stress intensity parameter have been determined for nine tungsten carbide–cobalt alloys by a wedge loaded double cantilever beam test. The nine alloys studied had uniform average grain sizes ranging from 1.5 to 8 microns, and cobalt contents from 3 to 15 wt %. The implications of these data have been discussed as they affect the theories of strength of cemented carbides. The critical strain energy release rate depended on the energy absorbed in the area adjacent to the tip of a metastable crack in the material. The energy absorbed at the tip of the crack depended on the amount of plastic work done on the binder contained in the plastic yield zone, as no flow was detected in the tungsten carbide particles. The amount of plastic work done on the binder in the yield zone was dependent on the volume of binder which plastically flowed, which in turn was dependent on the binder film thickness, and the number of grains (and binder films) the plastic zone included. As a result, the critical strain energy release rate generally increased as the binder film thickness increased. The mode of fracture of a tungsten carbide–cobalt alloy varied widely depending on several compositional and microstructural factors. If the plastic zone radius was less than one grain diameter, then the alloy would fail through the binder, regardless of the carbide grain size. If the plastic zone size was large enough to include several grains, then the failure mode would depend on the carbide grain strength; the larger grained alloys (weak grains) would fail through grain fracture, the smaller grained alloys would fail through ductile binder failure. Medium grain size alloys with large plastic zone sizes would fail with various amounts of the above modes, depending on cobalt content and grain size. The larger the cobalt content and the larger the grain size the more fracture would tend to be transgranular. The strength of these alloys in tension depended on the inherent flaw size, yield strength, and fracture toughness. The shape of the transverse rupture strength versus binder film thickness curve was a necessary result of these factors. The compressive strength of these alloys was dependent on carbide grain strength and dislocation density in the binder at the failure stress. The stress imposed on the grains of tungsten carbide–cobalt alloys has been found to be constant for a given grain size regardless of cobalt content, and as a result the compressive strength will rise as the binder film thickness goes down for a given grain size. (Diss. Abstr. Int., B)

12416 STUDY OF THE FORMATION AND ORDERING OF PLANAR DEFECTS IN SLIGHTLY REDUCED VANADIUM DIOXIDE BY ELECTRON MICROSCOPY. Plougonven, C. H. Evanston, IL; Northwestern Univ. (1972). 224p. University Microfilms Order No. 72-32,542.

Thesis.

The well-known ordered shear phases in the vanadium–oxygen system, possessing the general formula V_nO_{2n-1} ($4 \leq n \leq 8$), were investigated with the aim of elucidating the mechanism by which such ordered phases are produced from the parent VO_2 structure as it becomes oxygen deficient. For this purpose, small single crystals of $VO_{2.003}$ and $VO_{1.995}$ were grown by the vapor decomposition method of $VOCl_3$ in the presence of H_2O to maintain an appropriate oxygen partial pressure. The crystals were then annealed at 800°C for 3 to 5 weeks and were investigated first by an x-ray powder diffraction method, by measuring the electrical resistance from room temperature through the semiconductor-to-metal transition range (to 80°C), and by oxidizing a small portion of crystals to V_2O_5 and measuring the accompanying weight change. The crystals were then observed using thin-specimen transmission microscopy using a 200 kV electron microscope. Isolated stacking faults have been observed running through the crystal; by combining information from electron diffraction and direct imaging of the faults, their plane has been indexed and found to be of the $\{1\ \bar{2}\ 1\}$-type. Contrast analysis gave as a possible displacement vector $\frac{1}{2}[0\ 1\ 1]$, but presumably a little shorter to account for the weak contrast with the (0 0 2) reflection. Isolated faults were always bent in the crystal (zig-zag shaped) and were predominantly on two planes, $(1\ \bar{2}\ 1)$ and $(\bar{1}\ 2\ 1)$, although as many as four different planes of faults have been observed in the same area of a crystal. In slightly more reduced specimens, microdomains of ordered and partially ordered structures have been observed. The diffraction patterns revealed the existence of areas of the VO_2 tetragonal structure with regularly spaced crystallographic shear planes along $(1\ \bar{2}\ 1)$, corresponding to the higher order shear phases V_9O_{17} and $V_{10}O_{19}$. Electron microscope images clearly revealed microstructures. Single phase material did not occur and the bands on the direct images were interpreted to result from a two-phase mixture. The structures were multiply-twinned and twins occurred predominantly on (0 0 2) planes, although the twin on (0 2 0) was seen occasionally. A structure model for the fault was given, assuming a $(1\ \bar{2}\ 1)$ plane with a $\frac{1}{2}[0\ 1\ 1]$ displacement vector. A computer program was written to draw the stacking of planes of atoms parallel to an (h k l) plane in the rutile-type structure with faults present on $(1\ \bar{2}\ 1)$. It is found that, even if the $\frac{1}{2}[0\ 1\ 1]$ displacement vector is crystallochemically reasonable because it corresponds nearly to an edge of a VO_6 octahedron, it leads to a slight distortion of the oxygen lattice, and because of the repulsion of two vanadium

atoms planes, the distortion must still be greater. The direct images of the isolated faults, widely spaced in the crystal and sometimes bounded by partial dislocations are in support of the Anderson–Hyde model. Thus, even a slight degree of nonstoichiometry in reduced VO_2 crystals appeared to be accompanied by the production of planar defects. As their number increased, micro-domains of partially ordered phases appeared coherently intergrown in a VO_2 matrix. The formation of these micro-domains from a crystal with randomly distributed shear planes implies that these are able to migrate sideways and involves cooperative motion of the metal atoms as proposed by Andersson and Wadsley. A discussion of the nature of the forces responsible for the observed aggregation is speculative at this time but they are clearly long-range and there must be repulsive and attractive forces if the observed micro-domains correspond to an equilibrium configuration. It is likely that elastic strain in the crystal plays an important role in the formation of bent faults and in the subsequent ordering of these faults. (Diss. Abstr. Int., B)

12417 SOLIDIFICATION OF NIOBIUM–NIOBIUM CARBIDE EUTECTIC AND OFF-EUTECTIC COMPOSITES BY THE ZONE MELTING TECHNIQUE. David, S. A. Pittsburgh; Univ. of Pittsburgh (1972). 144p. University Microfilms Order No. 72-30,782.

Thesis.

Growth from the melt of niobium–niobium carbide ($Nb-Nb_2C$) composites at the eutectic and off the eutectic composition by electron beam floating zone melting and freezing was studied. Growth rate, composition, size of specimen, and liquid zone length were found to be important factors in determining the perfection of the micromorphology of the composites. Composite growth has been successfully achieved at compositions up to four atomic percent above the eutectic. The volume fraction of the carbide phase was increased from twenty-six percent to thirty-three percent by growing off the eutectic composition. Lamellar spacing varied inversely with the 0.4 power of growth rate and appeared independent of composition. The carbide morphology was both rod-like and plate-like. The transition was gradual. For a given composition, the change from plate to rod morphology occurred with increasing growth rate. For constant growth rate, the plate-like morphology was promoted by increasing carbon content and, hence, with increasing volume fraction of the carbide phase. Banding was the primary macro-defect observed. Three types of band morphologies were observed. Banding could be controlled by using good practice, as defined by this study, and by taking two zone leveling passes before growth of the composite. Nonuniformity in the feed rod is a major factor leading to banding in composite growth by zone melting. The liquidus line for the freezing of hypereutectic niobium–carbon alloys was redetermined in agreement with published results. The eutectic composition was relocated at 10.9 atomic percent carbon. (Diss. Abstr. Int., B)

12418 URANIUM-MODIFIED ZINC OXIDE VOLTAGE VARIABLE RESISTOR. Matsuoka, Michio; Masuyama, Takeshi; Iida, Yoshio (to Matsushita Electric Industrial Co., Ltd.). U. S. Patent 3,699,058. 17 Oct 1972. Priority date 22 Oct 1968, Japan.

A voltage variable resistor ceramic composition consisting essentially of zinc oxide and, as an additive, uranium oxide is described. The uranium-modified zinc oxide voltage variable resistor has improved voltage nonlinear properties due to the further addition of bismuth oxide, calcium oxide, and cobalt oxide. (Official Gazette)

12419 PREPARATION PROCEDURE OF CUBIC BORON NITRIDE. Sirota, N. N.; Mazurenko, A. M. (to Institut Fiziki Tverdogo Tela i Poluprovodnikov). Belgian Patent 782,059. 13 Apr 1972. (In French).

A procedure is described for the preparation of cubic boron nitride beginning with hexagonal boron by action on the latter simultaneously by pressure and high temperature during a period of time sufficient for the formation of a cubic structure. The pressure used is between 50 and 90 kilobars and temperature is at least 1800°C and at most 3000°C. (tr-auth)

12420 SYSTEM MeO–WO_3 WHERE Me = Ca, Sr, OR Ba. Tokunov, O. I.; Kislyakov, I. P. (Moscow Inst. of Fine Chemical Tech.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 15: No. 11, 1609-12(1972). (In Russian).

The three systems CaO–WO_3, SrO–WO_3, and BaO–WO_3 were investigated by high-temperature microscopy, and differential thermal and x ray analysis, and melting point diagrams were constructed up to WO_3–75% MeO. All three systems possessed congruently melting compounds $MeWO_4$ and Me_3WO_6. In addition, the congruently melting compounds $2SrO \cdot WO_3$ and $2BaO \cdot WO_3$ were detected, with melting points of 1,590 and 1,550°C, respectively. (KSW)

12421 DEVELOPMENT OF CARBIDE COATINGS FOR GRAPHITE FILAMENTS. Rashid, M. S. (Ames Lab., IA); Wirkus, C. D. Amer. Ceram. Soc. Bull.; 51: No. 11, 836-9 (Nov 1972).

Protective coatings of niobium and tantalum carbide were applied to five different commercially available graphite filaments (both polyacrylonitrile-derived (PAN) and rayon types, 6–8 μm diam) using a liquid metal, tin, transfer agent (LMTA) technique. The PAN type filaments have a circular cross section and a smooth surface and were better suited for coating than the rayon type which have crenulated edges. The coatings were examined metallographically, by x-ray diffractometry, scanning electron microscopy, and electron probe microanalysis. They were adherent to the filament, continuous and uniform, and their thickness could be controlled to a minimum of approximately 0.5 μm. These coatings offer promise as diffusion barriers on graphite filament reinforcements in superalloy matrix composites. (auth)

12422 ZIRCONIA–YTTRIA SYSTEM ABOVE 2000 C. Skaggs, S. R. Albuquerque, NM; Univ. of New Mexico (1972). 136p. University Microfilms Order No. 72-30,736.

Thesis.

The zirconia–yttria phase diagram was completed by preparing 254 spherules 2–2.5 mm diameter fused from premixed powder pellets with a 250 watt continuous wave carbon dioxide laser. The 10.6 μm infrared laser radiation is invisible to the eye, to photographic film, and to optical pyrometry. Other advantages of the laser as an imaging heat source are its continuously variable power, and its simplicity of operation. Spherule temperatures were measured on both pendant drops and falling drops. Fifty-two liquidus temperature measurements by automatic photoelectric pyrometer were made on pendent spherules from previously analyzed groups. Cooling curves and phase transformations were measured by recording light intensity vs time on a photomultiplier-oscilloscope combination. Temperature conversion from intensity data was by Planck's law. Pendent spherules were allowed to cool slowly to achieve crystal and chemical equilibrium. Falling droplets were quenched from approximately 2100°K to 87°K by liquid argon. Cooling times of 1 to 1.5 seconds from 3200°K to 87°K were achieved. The 2 to 2.5 mm diameter spherules were divided. One part was examined by x-ray diffraction using the 114.6 mm Debye–Scherer powder camera. The data were fitted by a Nelson–Riley correlation to determine the lattice parameter a_0. A petrographic thin-section was prepared on the other part of the spherule. Microscopy and electron microprobe analysis were performed on the thin-section to determine crystal structure and chemical composition. Ninety-four spherules of compositions varying from 0.1 to 98.6 mole % Y_2O_3 in ZrO_2 were examined by the x-ray powder diffraction method for lattice parameter, and by the electron microprobe x-ray analyzer for chemical composition. Data from the quenched spherules were in excellent agreement with the work of Duwez et al., (1951) and Ruh et al., (1968). The complete phase diagram was constructed from the data of Duwez et al., (1951), some unpublished data compliments of Ruh et al., (1968), and the measurements made in these experiments. Important new features include the appearance of the maximum temperature on the liquidus curve at ~10 mole % Y_2O_3 rather than at 20 to 25 mole % Y_2O_3 found by the previous investigators, a peritectic isotherm at 2483°C, and a peritectic composition located at 75 mole % Y_2O_3. All other features of the phase diagram appear in previously published work. The method demonstrates the successful use of the carbon dioxide laser as a heat source to study refractory oxide systems without the use of a container. (Diss. Abstr. Int., B)

12423 TRANSITION OF OXIDE FILM ON A MOLYBDENUM SURFACE FROM A TWO-DIMENSIONAL STRUCTURE TO A THREE-DIMENSIONAL STRUCTURE. Kolot, V. Ya.; Tatus, V. I.; Vodolazhchenko, V. V.; Rybalko, V. F.; Fogel, Ya. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1184-8(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1486-91(Jul 1972).

A method based on secondary ion–ion emission is used for the first time to study the transition of an oxide film from a two-dimensional to a three-dimensional phase on a molybdenum surface. This transition is observed at oxygen pressure of 1×10^{-7} to 5×10^{-6} torr and in the temperature range 1100 to 1300°K. At lower and higher temperatures the formation of the three dimensional phase of molybdenum oxides is not observed. It is shown that nucleating centers of three-dimensional oxides are formed at the surface at the initial formation of the three-dimensional phase; the number and size of these centers increase with the time of interaction between the oxygen and the molybdenum surface. A continuous oxide film is formed after some time. The oxygen pressure has a significant effect on the formation of a three-dimensional oxide film: At higher oxygen pressures the three-dimensional phase forms earlier and the rate of formation

of three-dimensional oxides increases. The results obtained indicate that the formation and growth of the nucleating centers of the three-dimensional phase are governed by diffusion processes at the surface. (auth)

12424 PHASE DIAGRAM AND THERMODYNAMIC DATA FOR THE HYDROGEN/VANADIUM SYSTEM. Griffiths, R.; ryde, J. A.; Righini-Brand, A. (Polytechnic, London). J. Chem. Soc., Faraday Trans., I; 68: No. 12, 2344-9(1972).

Ultrahigh vacuum techniques were used to investigate the hydrogen–vanadium system in the pressure, temperature, and concentration ranges 10^{-7} to 10 torr (1 torr = 133.32 N m^{-2}), 260 to 460°K, and H/V = 0 to 0.85 (concentrations are expressed in terms of hydrogen atom to metal atom ratios). The variations of the thermodynamic properties of the solid solution (α-phase) with composition have been determined, and the entropy data were compared with a model assuming random distribution of hydrogen in the metal and one site per metal atom. (auth)

12425 POTENTIALITIES OF CARBONITRIDES AS THE HARD CONSTITUENT OF SINTERED HARD ALLOYS. Bilyk, I. I. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 6, 466-70(Jun 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 6, 49-54(Jun 1972).

A review of research on preparation and properties of carbonitrides is presented. It is noted that at present investigations of carbonitrides are in their early stages. Data are included on properties, lattice constants, and microstructure of transition metal carbonitrides. (JRD)

12426 RELATION BETWEEN THE PROPERTIES OF MONOCARBIDES OF GROUPS IV–V TRANSITION METALS AND THEIR CARBON CONTENT. Vinitskii, I. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 6, 488-93(Jun 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 6, 76-82(Jun 1972).

Properties of Groups IV and V monocarbides whose homogeneity regions differ were examined. Information is included on microhardness, thermal expansion, lattice parameters, electron work functions, magnetic properties, heat capacity, and superconductivity. (JRD)

12427 KINETICS OF THE HOT PRESSING OF TITANIUM AND TUNGSTEN CARBIDE ALLOYS CEMENTED WITH NIOBIUM. Koval'chenko, M. S.; Bogomol, I. V.; Serebryakova, T. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 6, 441-5(Jun 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 6, 15-21(Jun 1972).

A study was made of sintering kinetics in the hot pressing of TiC–Nb and WC–Nb cermets containing 25, 50, and 75 at. % of binder metal. It was established that the highest relative density (0.93 to 0.96 and 0.94 to 0.97%) in the hot pressing of TiC–Nb and WC–Nb cermets is attained at temperatures of 2100 to 2375 and 2100 to 2300°C, respectively, a pressure of 300 kg/cm^2, and a holding time of 10 to 15 min. Experimental data on densification kinetics in the sintering of TiC–Nb and WC–Nb cermets were processed within the framework of the theory of volume viscous flow of porous solids, and the energy of activation for the sintering process was calculated. It was found that the hot pressing process comprises a transient and a steady-state creep stage and that the energy of activation for sintering of TiC–Nb and WC–Nb alloys decreases with rise in the amount of the metallic component. (auth)

12428 EFFECT OF CONDITIONS OF PEPARATION OF METALLIC TUNGSTEN ON THE PROPERTIES OF T15K6 ALLOY. Meerson, G. A.; Kreimer, G. S.; Glushkov, V. N.; Panov, V. S. (Moscow Inst. of Steel and Alloys). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 6, 452-5(Jun 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 6, 31-5(Jun 1972).

A study was made of the single-stage reduction of WO_3 to W in an industrial muffle furnace with a direct-flow feed of hydrogen into the furnace muffle. It is shown that, with hydrogen supplied by the direct-flow technique, it is possible to produce in a single stage, at unchanged furnace output, a homogeneous, fine-grained tungsten powder with an adsorption of more than 0.2 mg/g and a mean particle size of <1μ. An investigation was carried out of the effect of sintering temperature on the properties of T15K6 alloy produced from tungsten powder prepared by the direct hydrogen flow technique. It is shown that, compared with a standard T15K6 alloy, an alloy of the same composition produced from tungsten powder prepared in a muffle furnace with a direct-flow hydrogen supply possesses a finer-grained WC phase structure and superior physicomechanical and cutting properties. (auth)

12429 STABILITY OF CONCENTRATED INTERSTITIAL SOLUTIONS IN NIOBIUM. Anuchkin, A. M.; Volkov, A. K.; Goritskii, V. M.; (and others) (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved.; 34: No. 2, 366-77(Aug 1972). (In Russian).

The mechanical properties of solid solutions of Nb–O, and Nb–N were studied as functions of the temperature (77 to 473°K) and of the concentration (0.03 to 2.5 at. % O and 1.5 at. % N). The temperature dependence of the limits of creep altered slightly with concentration. Two mechanisms for strengthening interstitial solutions are discussed. The first concerns a strong temperature dependence of flow stress, and may depend on concentration only at <0.01 at. %. The other is athermal and its role is valid at a concentration of 0.01 to 1 at. %. (tr-auth)

12430 PREPARATION OF YTTRIUM NITRIDE. Lyutaya, M. D.; Goncharuk, A. B. (Inst. of Problems of Materials Science, Kiev). J. Appl. Chem. USSR (Engl. Transl.); 45: No. 7, 1509-1512(Jul 1972).

Translated from Zh. Prikl. Khim.; 45: No. 7, 1447-1450(Jul 1972).

A study of the interaction of yttrium of different purity grades with nitrogen and ammonia showed that in order to obtain yttrium nitride close to the calculated composition nitriding of high-purity yttrium shavings in nitrogen or in ammonia must be conducted at a temperature close to the melting point of the metal. The presence of impurities in yttrium alters the rate of nitriding of the metal in ammonia considerably. (auth)

12431 AZOTIROVANIE TUGOPLAVKIKH METALLOV. (Nitriding of Refractory Metals). Kiparisov, S. S.; Levinskii, Yu. V. Moscow; Metallurgiya (1972). 160p.

This monograph is concerned with the nitriding reaction of the metals Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, and W, and examines the kinetics and equilibrium involved in the reactions. Diffusion of nitrogen in the nitrides of metals like Zr and Nb and the temperature dependence of such diffusion are subjects of considerable importance to a study of nitriding. The properties of solid solutions of N in the refractory metals and the nitride phases, technical nitriding processes, and practical aspects of nitrided metal parts are examined. (198 references) (KSW)

12432 PHASE EQUILIBRIUM AND CRYSTAL GROWTH IN THE SYSTEM LITHIUM OXIDE–MOLYBDENUM OXIDE. Brower, W. S.; Parker, H. S.; Roth, R. S.; Waring, J. L. (National Bureau of Standards, Washington, DC). J. Cryst. Growth; 16: No. 2, 115-20(Nov 1972).

The phase equilibrium relationships of the Li_2MoO_4–MoO_3 system were determined in air. Two intermediate compounds were found to occur in the system and single crystals of these compounds were grown by the Czochralski technique. The first compound $Li_4Mo_5O_{17}$ was found to melt congruently at 544°C. The X-ray pattern of $Li_4Mo_5O_{17}$ was indexed on the basis of a triclinic cell a = 6.786 Å, b = 9.481 Å, c = 10.812 Å, α = 107°1′, β = 88° 48′, γ = 110° 12′. The second intermediate compound $Li_2Mo_4O_{13}$ was found to melt incongruently at 568°C, and to occur in two polymorphic forms. The X-ray pattern of the first form was indexed on the basis of a triclinic cell a = 8.227 Å, b = 8.503 Å, c = 11.46 Å, α = 95° 24′, β = 109° 17′, γ = 96° 31′ and the second form was indexed on a similar triclinic cell a = 8.192 Å, b = 8.597 Å, c = 11.580 Å, α = 111° 17′, β = 93° 55′, and γ = 96° 5′. (auth)

12433 CdO SINGLE CRYSTAL GROWTH BY SUBLIMATION. Fischer, K. J.; Spear, K. E. (Pennsylvania State Univ., University Park). J. Cryst. Growth; 16: No. 2, 142-6(Nov 1972).

A vaporization-condensation process in a vertical temperature gradient was used to grow single crystals of cadmium oxide. The resulting black CdO crystals exhibited excellent surfaces and average sizes of 60 to 150 mm^3. The process was carried out under different constant oxygen partial pressures, with experiments at the higher partial pressures giving crystals of higher purity. The best crystals grew directly on the CdO charge material where the cadmium pressure was relatively high, but the supersaturation was very small. Oriented crystallization in this sintered charge material was also observed to occur. (auth)

12434 FLUID-BED PREPARATION OF NIOBIUM CARBIDE. Gal, V. V.; Nikitin, K. A. (Inst. of High Temperatures, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 7, 596-8 (Jul 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 7, 100-3(Jul 1972).

Aspects of NbC preparation by diffusion impregnation metallization of graphite in fluidized beds were examined. The growth kinetics of NbC layers on dense graphite were studied at 1500 to 3000°C in fluidized beds using process durations of 5 min to 3 h. It was found that layer growth rate plots are straight lines at all

temperatures. Layer thickness was found to increase linearly with time. (JRD)

12435 PHYSICOMECHANICAL PROPERTIES OF CARBIDE FIBER MATERIALS. Kats, S. M.; Gorin, A. I.; Semenov, M. V. (Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 7, 585-9(Jul 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 7, 87-92(Jul 1972).

Physicomechanical properties of ZrC felt materials were studied. Results of measurements of thermal conductivity, electric conductivity, tensile strength, modulus of elasticity, and short time creep are included and discussed. (JRD)

12436 RATE OF GROWTH OF REFRACTORY OXIDE PARTICLES IN POWDER METALLURGICAL NICKEL. Buntushkin, V. P.; Potemkin, A. I. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 7, 581-4(Jul 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 7, 82-6(Jul 1972).

Preparation and properties of Ni composites containing Al_2O_3, Y_2O_3, and HfO_2 were studied. Results of metallographic and hot hardness studies of these composites lead to the conclusion that at low matrix porosities, processes which promote growth of refractory oxide particles dispersed in the matrix take place at 800°C and higher. (JRD)

12437 CONTACT REACTION OF REFRACTORY COMPOUNDS WITH LIQUID METALS. I. REACTION OF CARBIDES OF SUBGROUP-IVa METALS WITH THE IRON-GROUP METALS. Samsonov, G. V.; Panasyuk, A. D.; Kozina, G. K.; D'yakonova, L. V. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 7, 568-71(Jul 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 7, 66-70(Jul 1972).

A study was made of the reaction of liquid iron-group metals with carbides of Subgroup-IVa metals. It was established that a reaction does take place in these systems, resulting in the formation of limited solid solutions and eutectic alloys. The distribution of wetting metals in the carbides was investigated by electron-probe microanalysis. It was found that the averaged distribution of the iron-group metals over the depth of carbide specimens is closely approximated by a hyperbolic function. The nature and concentration of the wetting metal and the reaction temperature are the key factors controlling the distribution of wetting metals in the contact zone. (auth)

12438 CONDITION OF TITANIUM AND VANADIUM MONONITRIDE PARTICLES AFTER NITRIDING AND HEAT TREATMENT. Khaenko, B. V. Kachkovskaya, E. T.; Frenkel, O. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 7, 541-5(Jul 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 7, 34-9(Jul 1972).

Results of investigations concerned with the effects of heat treatments on nitrided VN and TiN are presented. It was established that, in the initial condition, titanium and vanadium mononitride preparations produced by direct nitriding techniques are never in a state of equilibrium. The cross section of each grain has a nitrogen concentration gradient which may reach the limiting composition in the surface layer under certain nitriding conditions. It is shown that, to obtain equilibrium preparations, specimens of the mononitrides must be subjected to additional annealing for several hours at 1200 to 1400°C under conditions precluding their further nitriding. Using equilibrium specimens, the boundaries of existence of titanium and vanadium mononitrides at temperatures ranging from ~800 to 1400°C were redefined with greater precision. (auth)

12439 ENERGY OF MIXING IN THE SYSTEMS AlSb–GaSb AND InAs–GaAs. Abdukarimov, E. T.; Nikitina, G. V.; Ostanina, K. V.; Romanenko, V. N. (Leningrad Higher Engineering Naval Academy). Dokl. Akad. Nauk Uzb. SSR; No. 11, 26-8(1971). (In Russian).

From phase composition data published by other workers, energies of mixing in binary systems were calculated: for the system InAs–GaAs, this energy was 5,000 cal/mole; for the system AlSb–GaSb, 2,000 cal/mole. (KSW)

12440 IRRADIATION DAMAGES OF THE NUCLEAR FUELS. Avram, Magdalena (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 8, 1013-1021(1972). (In Rumanian).

Discussion is presented on: types of radiation damage; effects of ionization and electronic excitation; interstitial atoms and vacancies; displacement energy; number of displacements produced by several radiations; thermal and displacement spikes; impurity atoms; and annealing radiation damage. (auth)

Metals and Alloys

Refer also to abstracts 11965 and 13905.

12441 Zr Hf NEWSLETTER, DECEMBER 1972. Akron, NY; AMAX Specialty Metals Division (1972). 16p.

Research and development on hafnium and zirconium and their alloys and compounds are reviewed. Information is included on Hf metal, Hf alloys, Zr metal, Zr alloys, Zr production, Zr compounds, and Hf compounds. 306 references are listed. (J.R.D.)

12442 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Oktober 1972. Band 6, Heft 10. 210 Referate (Register-Nr.2919-3515); 66 Referate (Register-No.689 T-754 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. October 1972. Vol. 6, No. 10. 210 Abstracts (Register No. 2919-3415); 66 Abstracts (Register No. 689 T-754 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H. (1972). 152p. (In German and English).

12443 ANNUAL REVIEW OF MATERIALS SCIENCE. VOLUME 2. Huggins, R. A. (ed.). Palo Alto, CA; Annual Reviews Inc. (1972). 787p. $10.00.

Twenty-two chapters are included, and a separate abstract was prepared for each of seven. (MHR)

For abstracts of individual chapters see: 11645, 12499, 12561, 12575, 12576, 13357, and 13889.

Corrosion and Erosion

Refer also to abstracts 11667, 11744, and 13975.

12444 (CEA-R-4361) ROLE OF HYDROGEN IN THE STRESS CORROSION CRACKING OF AUSTENITIC STEELS IN CHLORIDE SOLUTIONS. ESTABLISHMENT OF A POSSIBLE MECHANISM FOR THIS TYPE OF FISSURATION. Fidelle, J. P.; Broudeur, R.; Pellissier-Tanon, A.; Roux, C. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Oct 1972. 40p. (In French). Dep. NTIS (U. S. Sales Only).

12445 (EUR-4892) FUEL-CLADDING COMPATIBILITY OF STAINLESS STEELS WITH GAS AND SODIUM BONDED URANIUM PLUTONIUM CARBIDE FUELS. Goetzmann, O.; Ohse, R. W. (Kernforschungszentrum, Karlsruhe (West Germany)). 1972. 20p. Dep. NTIS (U. S. Sales Only).

An assessment is made of the compatibility of stainless steels with gas and sodium-bonded uranium carbide–plutonium carbide fuels by considering compatibility results, thermodynamic data and phase relationships. The fuel stabilization is considered both on the basis of the carbon potential of the fuel and the buffering carbides, and on their location in the appropriate phase diagram. The influence of the radial temperature gradient and burnup on the carbon potential of the fuel is discussed. Finally, clad carburization, carbon activity and solubility in steel and sodium, and its effect on the mechanical properties of the steel are considered with special attention to carbon transfer and the effects of oxygen dissolved in the sodium. (auth)

12446 (ORNL-TM-3863) DESIGN AND OPERATION OF A FORCED-CIRCULATION CORROSION TEST FACILITY (MSR-FCL-1) EMPLOYING HASTELLOY N ALLOY AND SODIUM FLUOROBORATE SALT. Huntley, W. R.; Gnadt, P. A. (Oak Ridge National Lab., Tenn.). Jan 1973. Contract W-7405-eng-26. 66p. Dep. NTIS.

A forced-circulation loop (MSR-FCL-1) was assembled and operated to evaluate the compatibility of standard Hastelloy N with sodium fluoroborate–sodium fluoride eutectic ($NaBF_4$–8 mole % NaF) coolant salt at operating conditions expected in the Molten-Salt Reactor Experiment coolant circuit. The salt velocity in ½-in.-OD, 0.042-in.-wall tubing was nominally 10 fps. Hastelloy N corrosion specimens were exposed to the circulating salt at temperatures of 950, 1030, and 1090°F. The test has operated more than 10,000 h at these conditions and tests are continuing. This report is mainly concerned with the design, fabrication, and operation of the facility. Special problems related to accommodating the BF_3 vapor pressure of the salt were resolved, and the sodium fluoroborate demonstrated heat transfer characteristics that could be approximated by conventional correlations such as the Dittus–Boelter equation. Corrosion rates generally decreased with operating time; for example, the lowest corrosion rate observed for the 1090°F corrosion specimens during a 2900 h test interval was equivalent to 0.0003 in. of uniform material removal per year. (auth)

12447 ROLE OF DISSOLVED OXYGEN IN THE CORROSION OF TITANIUM AND ZIRCONIUM BY LIQUID SODIUM. Barker, M. G.; Wood, D. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., Dalton Trans.; No. 22, 2451-4(1972).

The corrosion of titanium and zirconium by liquid sodium containing dissolved oxygen has been found to take place by the formation of nonadherent ternary oxides, in addition to the well known binary oxides, and oxygen solid solution in the metals. The compounds Na_4TiO_4 and Na_2ZrO_3 have been identified on the surface of titanium and zirconium after immersion in liquid sodium containing dissolved oxygen at temperatures close to 600°C. The oxides were identified by their x-ray powder diffraction patterns which were recorded through a matrix of sodium. The lattice parameters of the underlying transition metal were measured enabling the approximate amount of oxygen in solid solution in the metal to be calculated. The characterization of ternary oxide corrosion products, in addition to binary oxides and solid solutions of oxygen in the metal, enabled a comprehensive mechanism of corrosion for titanium and zirconium in the presence of liquid sodium to be postulated. (auth)

12448 HIGH TEMPERATURE BEHAVIOUR OF A VARIETY OF STEELS AND ALLOYS IN HELIUM AND ITS IMPURITIES. Berry, L.; Willermoz, H. pp 41-54 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

In a high-temperature reactor, the He may be contaminated by a variety of impurities that arise mainly from the reaction between steam, desorbed from the graphite or present due to slight leaks in the exchangers, and various reactor components, and also the accidental ingress of air in the event of depressurization. Under normal operating conditions, since there is continuous purification of the gas, an equilibrium condition should be set up between the impurities (H_2O, H_2, CO, CO_2, CH_4, and O_2). The relative proportions of the impurities, which will vary with temperature, will determine the oxidizing or reducing, and carburizing or decarburizing properties of the gaseous mixture. The reactions of the various impurities with one another, or with reactor components, that can occur either consecutively or concurrently, can be very numerous, and hence the thermodynamic laws they obey can be very complex. It is therefore difficult to use theoretically derived equations to predict the behavior of a particular material at any point of the reactor, especially if the material contains a large number of alloying elements. Tests are described designed to study the effect on metallic materials of the principal variables governing the thermodynamic equilibria, that is, the relative concentrations of the various impurities, temperature, and pressure. The materials studied included the low alloy steels Chromesco III, EM 12 and F 17 (430), at a temperature of 650°C; also the austenitic alloys of the 304L, 316L, 316-Ti, 321 (Ti-stabilized), 347 (Nb-stabilized) types, Incoloy 800, Inconel 625, Nimonic 75 and 80A and Hastelloy X and TZM. Amongst conclusions reached was that it seems that either the oxidizing ability of the gas does not depend solely on the H_2/H_2O ratio, or else that increase in pressure introduces another factor, which might be concerned with the coefficient of diffusion on O_2 through the thin oxide layers present on the surface of the materials. The investigation also confirmed the detrimental effect of even small additions of Ti and Al. (UK)

12449 CONTROLLED SOLIDIFICATION AND GROWTH; OXIDATION RESISTIVITY OF NiAl–Mo AND NiAl–Cr ALLOYS. Kinikoglu, N. G. Denver; Univ. of Denver (1972). 181p. University Microfilms Order No. 72-28,318.

Thesis.

Studies of microstructural changes in certain eutectic systems have resulted in numerous theories which, as experiments have indicated in many cases, can only be applied to a few specific systems. A new structure theory, based on the relation between planar interface, diffusion and surface-to-volume ratio, has been developed. By applying the existing published data, it was shown that the proposed theory, together with a proposed new undercooling term ΔTf, is able to explain most of the discrepancies that now exist between various theories and experiments. An ingot melting furnace has been built. A new type of controlled solidification unit has been developed. In this solidification unit the required temperature gradient is obtained by surrounding the specimen with a water-cooled sleeve. Specimens grown by this technique showed a nearly straight solid–liquid interface and a homogeneous structure throughout the ingot length. Rods consisting of parallel fibers of Cr or Mo about 1 μ in diameter and an aspect ratio greater than 10,000 have been made in the NiAl–Mo and the NiAl–Cr quasi-binary eutectic systems. Specimens up to 4 inches long by $\frac{3}{8}$ inch in diameter have been prepared. To improve the oxidation resistance of NiAl–Mo and NiAl–Cr, Ce and Si were introduced to the surfaces of these materials by surface coatings. The oxidation behavior of these alloys, with and without the surface charge, has been studied by their weight change and scale thickness. Surface charging did not affect the oxidation rate of NiAl–Cr and was detrimental to that of NiAl–Mo. At faces parallel to the growth direction, the composites have been found to be as resistant to oxidation as is their matrix. However a protective coating was necessary to control the oxidation of other surfaces. Short time tensile tests showed that NiAl–Mo is an extremely brittle material in the as-cast condition and less but still highly brittle when it is controlled solidified. Ni_3Al–W and Ni_3Al–20 a/o Nb_2C structures were surveyed by arc melted buttons. Studies showed the possibility of a eutectic Class I type reaction in the former and a peritectic reaction in the latter. (Diss. Abstr. Int., B)

12450 HIGH-TEMPERATURE OXIDATION OF COBALT–21 WT. PERCENT CHROMIUM–3 VOL. PERCENT Y_2O_3 ALLOYS. Stringer, J. (Univ. of Liverpool); Wright, I. G. Oxidation Metals; 5: No. 1, 59-84(Oct 1972).

Alloys of Co–21 wt % Cr–3 vol % Y_2O_3 have been prepared by a mechanical alloying method, and oxidized in oxygen at 100 Torr in the temperature range 900 to 1200°C. The general effects of the dispersed oxide phase were similar to those reported for nickel-base alloys: the selective oxidation of chromium to form a continuous protective Cr_2O_3 scale was promoted; the rate of growth of Cr_2O_3 was reduced compared to dispersoid-free alloys; the adhesion of the Cr_2O_3 was greatly improved; and the scale-forming reaction was probably at the scale–metal interface in the alloys containing the dispersoid, whereas it was at the scale–oxygen interface in dispersoid-free alloys. This last point has not been positively demonstrated. The improvement in adhesion was of particular significance, since the scales on cobalt-base alloys were prone to spallation, and it has been possible to study the mechanism of adhesion in more detail. It appears that in dispersoid-free material the metal recedes from the scale–metal interface, leaving the scale supported on the tops of metal peaks, but this did not happen in the alloy containing the dispersoid, either because the growth direction of the scale had been changed, or because of changes in the substrate grain size. In general, the observations supported the model proposed in an early study for the oxidation of Ni–20 wt % Cr alloys containing oxide dispersions. (auth)

12451 HIGH-TEMPERATURE OXIDATION OF NICKEL–20 WT. PERCENT CHROMIUM ALLOYS CONTAINING DISPERSED OXIDE PHASES. Stringer, J. (Univ. of Liverpool); Wilcox, B. A.; Jaffee, R. I. Oxidation Metals; 5: No. 1, 11-47(Oct 1972).

Alloys of Ni–20 wt % Cr containing 3 vol % of a dispersed oxide phase have been prepared by a mechanical alloying method and oxidized in oxygen at 100 torr in the temperature range of 900 to 1200°C. It appears that the dispersed oxide has four distinct effects on the oxidation: the selective oxidation of chromium to form a continuous protective Cr_2O_3 scale is promoted; the rate of growth of Cr_2O_3 is reduced compared with particle-free alloys; the adhesion of the Cr_2O_3 is greatly improved; and the scale-forming reaction appears to be at the scale–metal interface in alloys containing a dispersion, but at the scale–oxygen interface in alloys without a dispersion. It appears that the nature of the dispersed oxide is not important, since very similar effects can be obtained with ThO_2, Y_2O_3, and CeO_2 dispersions. It is demonstrated that a logical deduction from this evidence is that the growth of Cr_2O_3 scales on dispersion-free systems must involve short-circuit diffusion of chromium through the scale, and that it seems probable that an effect of the dispersion must be to retard or eliminate this short-circuit process. It is suggested that the oxide particles act as nucleation centers for the oxide, thus reducing the oxide grain size; and it is shown that this simple hypothesis is sufficient to explain a number of the experimental observations. (auth)

12452 FUNCTIONAL FORM OF RATE CURVES FOR THE HIGH-TEMPERATURE OXIDATION OF DISPERSION-CONTAINING ALLOYS FORMING Cr_2O_3 SCALES. Stringer, J. (Univ. of Liverpool). Oxidation Metals; 5: No. 1, 49-58(Oct 1972).

It has been shown recently in a number of investigations that the presence of dispersed stable oxides in chromium-containing alloys can result in the formation of protective Cr_2O_3 scales, which appear to grow considerably slower than similar scales on alloys not containing dispersoids. In addition, Cr_2O_3 is removed by further oxidation to the volatile species CrO_3, and the rate of this process is unaffected by the dispersoid. Simple kinetic models have been used to describe the results, but it is suggested, on the basis of a curve-fitting analysis, that these approaches are incorrect. (auth)

12453 PREDICTING CORROSION RATES WITH THE POTENTIOSTAT. Morris, P. E.; Scarberry, R. C. (International Nickel Co., Huntington, WV). Corrosion; 28: No. 12, 444-52(Dec 1972).

Most corrosion processes are electrochemical in nature, and in recent years increasing emphasis has been placed on electrochemical test methods. A new technique is described for using potentiostatically determined polarization curves which fulfills the requirements of a rapid electrochemical corrosion test. The test method makes use of the recently developed rapid-scan potentiodynamic technique to produce a series of polarization curves that describe an alloy's corrosion characteristics in the test environment. The method has yielded calculated corrosion rates that correspond to rates obtained from conventional long-term immersion tests. (auth)

12454 OXIDATION BEHAVIOR OF W–Ta ALLOYS. Yoda, Renpei; Itagaki, Takehiko (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 36: No. 11, 1121-4(Nov 1972). (In Japanese).

Although the refractory metals typified by W, Ta, and Mo show good mechanical properties at high temperature, their application is greatly limited because of their poor oxidation resistance. Thus, the oxidation properties of the W–Ta system were investigated. Samples were prepared by means of electron beam melting. It was found that all of the W–Ta alloys showed lower oxidation rates than pure W and Ta. Addition of 5% Ta to the W brought about a remarkable reduction oxidation rate, and the decrement remained almost unchanged until the addition of 30% Ta. The scale of these alloys consisted of $WO_{2.90}$. The lowest oxidation rate was attained at the composition of W–40 ~ 50% Ta, and its oxidation product was $3\,WO_3 \cdot Ta_2O_5$. Although the scale of these alloys was generally porous and had poor adherency with the metal matrix, only W–70% Ta alloy formed a compact and strong adhesive scale. But his W–70% Ta alloy was broken at the grain boundary when it was held for 30 ~ 40 min at 1000°C in oxidation atmosphere. W and Ta alloys make a continuous solid solution and the lattice parameters of the alloys used in this investigation also supported this fact, but the hardness curves of our specimens showed abnormality. (auth)

Preparation and Fabrication

Refer also to abstracts 11889, 11932, 11933, 13996, and 14075.

12455 (AD–746248) ELECTROLYTIC PREPARATION AND EVALUATION OF TUNGSTEN BRONZES. Christopulos, J. A. (Army Electronics Command, Fort Monmouth, N. J.). Jun 1972. 21p. (ECOM–3586). NTIS.

Mixed sodium-iron tungsten bronzes were electrolytically prepared from melts of tungstic oxide, sodium tungstate, and ferrous tungstate. The corrosion rate in 1F KOH appeared to be directly proportional to the oxygen partial pressure. Results of galvanostatic steady-state experiments for oxygen electroreduction in acid solutions were in agreement with existing knowledge that the rate determining step (r.d.s.) is a charge transfer step. In KOH, r.d.s. was not a simple charge transfer but some other process. (auth)

12456 (CONF-720958-1) RATCHETTING DEFORMATION AS AFFECTED BY RELATIVE VARIATIONS OF THE LOADING SEQUENCE. Anderson, W. F. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 1972. Contract AT(04-3)-700. 21p. Dep. NTIS.

From 27th annual petroleum mechanical engineering conference with the 3rd pressure vessels and piping conference; New Orleans, LA (27 Sep 1972).

As part of a program undertaken to obtain experimental verification of the magnitude and effect of creep ratchetting in high-temperature, sodium-cooled reactor design, tests have been performed to extend the range of the ratchetting test parameters from that of a previous study and to examine the effect of relative variations in the loading sequence. Test results over the extended range of parameters tend to verify the analytical predictions of the magnitude of plastic ratchetting strain per cycle made by Gree and by Burgreen. The sensitivity of the amount of ratchetting strain per cycle to the phase relation between the bend cycle (thermal transient) and the axial stress (internal pressure) indicates that care should be taken in preparing design specifications to properly show the variations in system pressure relative to the thermal transients and hold times. (auth)

12457 HAFNIUM BASED ALLOY. Kosteruk, V. P.; Kovalchenko, M. S. (to Institut Problem Materialovedenia). British Patent 1,292,307. 11 Oct 1972. Filed 12 Nov 1969.

The production of a Hf-based alloy suitable for use as a brazing or soldering material for high melting compounds such as boron carbonitride, boron nitride, silicon nitride and silicon carbide is described. The alloy has a melting point between 1,200 and 2,100°C and consists of one or more elements from subgroup B of the first group of the periodic table, to a total of 3 to 20% of the total alloy weight, together with one or more elements having a melting point above 600°C selected from the third to eighth groups to a total of 2 to 20% of the alloy weight, the balance being Hf. Examples are given. (UK)

12458 POWDER METALLURGY FOR HIGH-PERFORMANCE APPLICATIONS. Proceedings of the 18th Sagamore Army Materials Research Conference, Raquette Lake, New York, August 31–September 3, 1971. Burke, J. J.; Weiss, Volker (eds.). Sagamore Army Materials Research Conference Proceedings. Syracuse, N. Y.; Syracuse University Press (1972). 409p. $23.00. (CONF-710848).

Twenty-one articles are included; a separate abstract was prepared for each of seven. The remaining 14 articles contain information on: emerging technologies in powder metallurgy; high-pressure water atomization; specialty methods of powder atomization; fundamentals of sintering theory; early stages of mechanism of sintering; recent developments in the analysis of sintering kinetics; fundamental principles of powder preform forging; processing and properties of powder forgings; fabrication of high-strength Al products from powder; high-speed tool steels by particle metallurgy; production system and high-performance automotive applications; a high-temperature engineering ceramic (Si_3N_4) by powder-metallurgical methods; and the viability of an American powder-metallurgy industry. (P.C.H.)

For abstracts of individual papers see: 12459–12463, 12511, and 12512.

12459 COARSE POWDER TECHNIQUES. Widmer, R. (Industrial Materials Tech., Inc., Woburn, Mass.). pp 69-84 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

Since powders processed by hot consolidation do not necessarily have to be fine- and cold-moldable, this opens up a new field of particle metallurgy, different from classical powder metallurgy. Experiments were conducted with coarse powders of iron-, nickel-, and cobalt-base alloys as well as some titanium alloys. Coarse powders were consolidated by isostatic hot pressing and hot extrusion. Attractive mechanical properties were obtained. Coarse powders offer some advantages over fine powders primarily because contamination is less of a problem. In alloys with high-temperature creep requirements, microstructures with a large grain size can be developed rather easily. (auth)

12460 HOT ISOSTATIC PRESSING OF HIGH-PERFORMANCE MATERIALS. Hanes, H. D. (Battelle Memorial Inst., Columbus, Ohio). pp 211-30 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

Hot isostatic pressing (HIP) is rapidly achieving a place as a production process for a variety of high-performance powder-metallurgy materials. A general description of the process is given. Examples of powder-metallurgy shapes made by HIP are discussed. Properties of various high-performance materials, including beryllium, titanium, tool steels, and carbides, are given. Current and future applications of the process are also presented. (auth)

12461 COLD ROLLING OF DISPERSION-STRENGTHENED NICKEL. Norris, L. F.; Fraser, R. W.; Evans, D. J. I. (Sherritt Gordon Mines Ltd., Fort Saskatchewan, Alberta). pp 257-80 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

The cold rolling of dispersion-strengthened nickel is considered in terms of the mechanical aspects of rolling and the metallurgical response to rolling. Metallurgical response in this alloy is measured by the development of microstructures which can be characterized by the statistical parameters of the dispersoid distribution and by the grain size, grain shape, and grain orientation. The processing of a series of nickel-thoria powders to strip is used to illustrate the functional dependence of the physical and mechanical properties on the microstructure. (auth)

12462 DEVELOPMENT OF IN-100 POWDER-METALLURGY DISKS FOR ADVANCED JET ENGINE APPLICATION. Athey, R. L.; Moore, J. B. (Pratt and Whitney Aircraft, West Palm Beach, Fla.). pp 281-301 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

Powder metallurgy is becoming increasingly important for highly alloyed nickel-base superalloys used for turbine and compressor disks in advanced jet engines. These alloys, by virtue of their alloying constituents, are very segregation-prone, particularly when cast into ingots large enough to produce engine disks; hence, the attractiveness of the powder-metallurgy route. The development and utilization of an "all inert" powder-metallurgy concept and the Gatorizing forging process succeeded in producing turbine and compressor disks of IN-100 alloy for advanced engine use. The powder-manufacturing processes used, the methods of powder consolidation applied, the interrelationship of the powder product and the Gatorizing forging process, and the attributes of the final disk product are reviewed. (auth)

12463 COMPLEX SUPERALLOY SHAPES. Bufferd, A. S. (Whittaker Nuclear Metals, West Concord, Mass.). pp 303-16 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

Complex superalloy shapes prepared by powder-metallurgy techniques rely on the fine grain size and chemical homogeneity advantages of powder as compared to case and wrought material. Superalloy powders provide the basis for advanced metalworking techniques such as filled billet extrusion and rolling as well as for superplastic deformation in forging and drawing. Attention is directed not only to the metalworking process but to the influence of chemistry and heat treatment in developing engineering properties in complex shapes prepared with superalloy powders. (auth)

12464 CARBONYL IRON–NICKEL–MOLYBDENUM POWDERS. Belozerskii, N. A.; Segal, L. D.; Mel'tser, R. L.; Zelikhman, L. A. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 7, 515-517(Jul 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 7, 1-4(Jul 1972).

Carbonyl iron–nickel–molybdenum powders containing from 0.5 to 5.8% Mo were produced. The powders were found to be chemically pure; their total metallic-impurity content did not exceed 0.01%; they also contained small amounts of oxygen and carbon (0.5 to 1%), which could readily be eliminated by heat treatment in a hydrogen atmosphere at 400 to 600°C. Parts produced by pressing and heat treating carbonyl iron–nickel–molybdenum powders exhibit high magnetic properties. The magnetic characteristics of toroids made from a carbonyl powder containing 4.3% Mo were found to be much higher than those of rolled strip from cast 79NM4 alloy. These results show that the carbonyl process is suitable for the preparation of iron–nickel–molybdenum powders having the required molybdenum content. To obtain a powder of higher molybdenum content, it is necessary to add to the starting iron–nickel carbonyl mixture a solution of molybdenum carbonyl in an organic solvent or to raise the temperature at which the starting carbonyl mixture is prepared. Iron–nickel–molybdenum powders are an excellent starting material for the production of soft magnetic sintered components possessing high magnetic properties. (auth)

12465 FUEL CANS OUT OF ZIRCALOY. Energ. Tech.; 24: No. 9, 290(1972). (In German).

Fabrication of Zircaloy fuel cans, e.g., production program for the Mannesmann tube fabrication, rolling-mill equipment, heat treatment in vertical vacuum-furnace and quality control are described. (GF)

12466 VACUUM MICROBALANCE FOR THE INVESTIGATION OF CATHODE SPUTTERING IN A DISCHARGE WITH OSCILLATING ELECTRONS. Reikhrudel, E. M.; Smirnitskaya, G. V.; Kurbanova, L. R. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 4, 418-24(1972). (In Russian).

A vacuum microbalance is described for use in determining the effective coefficient of cathode sputtering in a discharge with oscillating electrons in a magnetic field. The cathode was fastened to one arm of a balance. The mass change of the cathode in the discharge was measured by the shift in the resonance curve of a circuit containing a condenser, one of the plates of which was suspended from the opposing arm of the balance. The effective coefficients of cathode sputtering were obtained for Ag, Ta, W, and Mo in N_2, Kr, and H_2 for different discharge parameters. The path of sorption and desorption of gases at the cathode may be followed by this method. (tr-auth)

12467 ION-CURRENT CHARACTERISTICS IN THE ELECTRON-BEAM ZONE-MELTING OF MOLYBDENUM. Brodskii, I. A.; Petushkov, E. E.; Mikhailov, S. M. pp 94-6 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Phenomena associated with the ionization of gases evolved from a molten zone of metal are considered. A method is given for measuring the ion current, and a relationship between the ion current and the quantity of evolved gases in a Mo zone-melting installation is derived. The use of the ion current to control the zone melting is suggested. (DLC)

12468 PROPERTIES OF Mn–Mo WELD FORMED MATERIAL FOR NUCLEAR REACTOR VESSELS. Ujiie, A.; Sato, S.; Shimoyama, T.; Matsumoto, O. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Mitsubishi Juko Giho; 9: No. 5, 637-48 (Sep 1972). (In Japanese).

Heavy pressure vessels and other components can be fabricated with high safety at lower costs and within a short period by the weld forming technique. In order to evaluate the properties of heavy thickness weld formed material corresponding to ASTM-A533 Gr. B for nuclear reactor vessels, 200 mm thick material was manufactured by the weld forming technique under heat treatment conditions obtained on the basis of the results of many tests conducted in the past. The metallurgical and mechanical properties of the material and notch toughness were examined in comparison with vacuum degassed rolled plates. As the result of this examination, it has been confirmed that the properties of the weld formed material completely satisfy the requirements of SA 533 Gr. B of ASME Sec. III and that the well formed material has superior mechanical properties, high fracture toughness and weldability, isotropic microstructure, and homogeneous chemical composition as compared with rolled plates. (auth)

12469 RESULTS OF THE RESEARCH ON SOLDERING AT HIGH TEMPERATURE OF AUSTENITIC STAINLESS STEEL AISI 304. van der Sluis, H. H.; van der Torre, D. Lastechniek; 38: 290-4(Dec 1972). (In Dutch).

A research-programme was carried out with a number of nickel-base and a gold-base brazing alloys on two types of stainless steel AISI 304, a ferritic steel 2¼ Cr-1 Mo and the nickel-base alloy Incoloy 800. The results on AISI 304 are described. The results on the other metals will be published in the course of 1973. A number of tests have been carried out in order to try to characterize the brazing alloy. The following items were investigated: wettability and spreading behavior of the brazing alloy on the basemetal; the erosion and penetration behavior of the brazing alloy; the ductility of a brazed joint; and the mechanical properties (shear-stress) of a joint. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 11745, 11892, 12403, 12437, 12980, 13832, 13880, 13892, 13917, 13918, 13983, 14249, and 14255.

12470 (AD–860078) SPALL STUDIES ON 6061-T6 ALUMINUM. Technical Report, January 1968–March 1969. Jajosky, C. Jr.; Ferdman, M. A. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Sep 1969. 92p. (AFWL-TR-69-101). NTIS.

Flat specimens of 32 mil 6061-T6 aluminum were dynamically shock loaded by high-velocity mylar flyer plates. A 16 kilojoule capacitor discharge system and exploding foil assemblies were used to accelerate 3, 5, 7.5, and 10 mil mylar flyers at spall threshold velocities between 0.5 and 2 mm/microsec. The environment between flyer and target was both normal and atmospheric air and vacuum. The spall threshold data were analyzed and an attempt was made to apply available predictive models. The data best fit the Tuler, et al., model, with a stress exponent of 1.8. This condition very closely approximates a pure-energy criterion for spallation. (auth)

12471 (FEI–278) FINE STRUCTURE OF TUNGSTEN–RHENIUM SOLID SOLUTIONS. Budagovskii, S. S.; Bykov, V. N.; Gavrilyuk, M. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 19p. (In Russian). INIS.

The effects of ductile deformation and thermal treatment were studied on the specific electroconductivity Hall constant, crystal lattice period, and spectrum of gamma resonance of ^{57}Fe nuclei of alloy systems of W–Re in the solid solution region. It was concluded that changes in the properties mentioned for the alloys with >6 at. % were associated with the origin of σ-phase. (tr-auth)

12472 (GEAP–13897) STRESS-RUPTURE BEHAVIOR OF AUSTENITIC STAINLESS STEEL TUBING. INFLUENCE OF COLD WORK AND EFFECT OF SURFACE DEFECTS. Lauritzen, T. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Jan 1972. Contract AT(04-3)-189. 32p. Dep. NTIS.

The influence of cold work and local surface defects on the stress-rupture behavior of austenitic stainless steel tubing was evaluated at 700°C. The program included annealed, 10, 20, 30,

and 50% cold-worked tubing of Type-316 stainless steel. These low-strain-rate tests, representing failure times as high as 14,500 hours, showed that tubing with 10% cold work is the strongest and most stable of the four cold-worked levels tested. The work further revealed that defects as deep as 20% of the tube wall do not degrade the stress-rupture strength of thin wall tubes of annealed, 10 and 20% cold-worked material tested to loads as high as 11,000 psi and corresponding rupture lifetimes of more than 1100 hours. However, such defects—particularly those on the inner surface—cause a substantial reduction in rupture ductility under similar loadings. (auth)

12473 (KHFTI-71-8) THERMAL EXPANSION COEFFICIENTS OF THE NIOBIUM-TITANIUM ALLOY AND TEXTOLITE WITHIN THE RANGE OF 5 TO 300°K. Golik, V. R.; Petrenko, N. S.; Popov, V. P. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 7p. (In Russian). INIS.

The temperature dependence of the linear expansion coefficient over the temperature range 5 to 300°K was determined for the superconducting deformed alloy Nb–60 Ti and for sheet textolite used for preparing superconducting solenoids. The linear expansion coefficient at the temperatures 10, 20, 50, 100, 150, 200, and 275°K were, 0.022, 0.059, 0.235, 0.52, 0.67, 0.76, and 0.83 (all × 10^{-5}), respectively. Corresponding values for textolite were from 2.5 to 3 times greater over this temperature range. (tr-auth)

12474 (LA-5055) PLUTONIUM-SCANDIUM SYSTEM. Ellinger, F. H.; Johnson, K. A.; Land, C. C. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 6p. Dep. NTIS.

The plutonium–scandium phase diagram was constructed from results obtained chiefly by x-ray diffraction and micrographic techniques. The principal features of the diagram were found to be as follows. (1) There is a continuous series of solid solutions between the body-centered cubic phases ϵPu and βSc. (2) Face-centered cubic δPu is stabilized to room temperature by the solution of about 11 at. % Sc, and a maximum of 23 at. % Sc, decreasing to about 20 at. % at room temperature, is soluble in δPu. (3) A maximum of about 47 at. % Pu, decreasing to about 25 at. % at room temperature, is soluble in hexagonal close-packed αSc. And (4) A double-hexagonal, close-packed, intermediate phase, ζ, forms peritectoidally at 753°C and has a homogeneity range of about 34 to 41 at. % Sc at 663°C. (auth)

12475 (N-72-25523) MECHANICAL PROPERTIES OF ELECTRON-BEAM-MELTED MOLYBDENUM AND DILUTE MOLYBDENUM-RHENIUM ALLOYS. Klopp, W. D.; Witzke, W. R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jun 1972. 21p. (NASA-TM-X-2576; E-6753). NTIS.

A study of molybdenum and three dilute molybdenum–rhenium alloys was undertaken to determine the effects of rhenium on the low temperature ductility and other mechanical properties of molybdenum. Alloys containing 3.9, 5.9, and 7.7 atomic percent rhenium exhibited lower ductile-brittle transition temperatures than did the unalloyed molybdenum. The maximum improvement in the annealed condition was observed for molybdenum–7.7 rhenium, which had a ductile-brittle transition temperature approximately 200°C (360°F) lower than that for unalloyed molybdenum. Rhenium additions also increased the low and high temperature tensile strengths and the high temperature creep strength of molybdenum. The mechanical behavior of dilute molybdenum–rhenium alloys was similar to that observed for dilute tungsten–rhenium alloys. (auth)

12476 (N-72-25524) THERMOMECHANICAL AND THERMOCHEMICAL BEHAVIOR OF A HAFNIUM-20 PERCENT TANTALUM ALLOY. Howell, J. P. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). 1971. 171p. (NASA-TM-X-68339). NTIS.

Thesis. Submitted to North Carolina State Univ., Raleigh.

An investigation was conducted to determine the thermomechanical and thermochemical behavior of a high temperature, oxidation resistant, hafnium–20 percent tantalum alloy. The elastic and shear moduli of this alloy were determined in air up to 1000°C and in vacuum up to 2000°C using a mechanical resonance technique. The internal friction of the alloy was measured up to temperatures greater than 1400°C. Room temperature stress–strain behavior of the oxidized and unoxidized alloy was established. The effects of annealing on the elastic and shear moduli of the extruded rod material were investigated. The martensitic-type phase transformation occurring in the alloy was studied using hot stage metallography and electron microscopy. Static oxidation tests were conducted on the alloy at temperatures from 1000 to 1700°C with weight gain measurements made as a function of time and temperatures. Surface morphology studies were conducted on the oxide coatings formed at the different temperatures using scanning electron microscopy and x-ray diffraction techniques. (auth)

12477 (ORNL-4839) MECHANICAL PROPERTIES AND STRUCTURE OF OXYGEN-DOPED TANTALUM-BASE ALLOY. Liu, C. T.; Inouye, H.; Carpenter, R. W. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 38p. Dep. NTIS.

Effects of oxygen doping on the mechanical properties and structure of Ta–8% W–2% Hf (T-111) alloy were studied. Internal oxidation treatments were performed on 0.02-in.-thick sheet material at 1000°C and 1 to 2×10^{-5} torr dynamic oxygen pressure. After being doped, the specimens were heat treated at various temperatures. Calculations based on the lattice parameter measurement indicate that the oxygen solubility in T-111 is low and equal to 100 ppM at 1700°C. The tensile properties of oxygen-contaminated specimens were determined in vacuum at temperatures to 1316°C. Specimens heat treated at 1700°C varied little in mechanical properties with oxygen content up to 3500 ppM. Beyond this level, the strength increased and ductility decreased abruptly with oxygen contamination. Heat treated T-111 lost its ductility completely when the oxygen content reached 4200 ppM; in contrast, the as-doped T-111 was brittle at an oxygen level of only 800 ppM. An extremely fine coherent precipitate was observed in electron micrographs of as-doped specimens. It coarsened upon annealing at or above 1400°C and eventually formed discrete HfO_2 particles. The structure and mechanical properties are correlated. (auth)

12478 (ORO-3508-8) DIFFUSION OF GASES IN SOLIDS: TRITIUM DIFFUSION IN REACTOR CLADDING MATERIALS; XENON DIFFUSION IN URANIUM DIOXIDE. Period Covered: November 1, 1971–October 31, 1972. Abraham, P. M.; Austin, John; Davis, John; Driscoll, Eugene; Starr, Kenneth; Elleman, Thomas; Verghese, Kuruvilla (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). 1972. Contract AT-(40-1)-3508. 66p. Dep. NTIS.

Analysis of tritium release data in austenitic stainless steels revealed a significant amount of permanent trapping in the surface region. These data were fitted to an existing trapping model to give values for the trapping parameters that obey the Arrhenius rate equation. Gas release studies from Zircaloy-2 samples were extended to the temperature range 25°C – 411°C and apparent diffusion coefficients in the surface region calculated. These coefficients are represented by $D = 0.12 \times 10^{-13} \exp [5{,}500 \text{ cal/RT}]$ $cm^2\ sec^{-1}$ and are less than the bulk diffusion coefficients in Zircaloy-2 by a factor 10^7 to 10^8. A few measurements of tritium release from Zircaloy-2 samples which had known amounts of oxide on the surface were conducted. The samples were oxidized for different times in 200 Torr pressure of oxygen at 500°C. The oxide thickness was measured by scanning electron microscopy. There is some indication that thick oxide layers (>0.2 μm) do not provide any additional barrier against tritium release. In order to assess the effects of surface regions with low diffusion coefficients on stainless steel and Zircaloy claddings on tritium release through the clad, a 3-region diffusion model of the cladding was formulated, solved analytically and numerically results computed for typical PWR and BWR clad thicknesses. The computed release fractions are in good agreement with literature data from fuel pin irradiations. In order to check the extent to which values of xenon diffusion coefficients reported in literature might have been influenced by gas atom trapping, trapping parameters measured in calcium fluoride were modified to suit UO_2 and used in Hurst's trapping model to predict the diffusion coefficients that should have been observed for the experimental conditions used by previous workers. It is shown that a significant fraction of the xenon diffusion coefficients reported in literature for UO_2 is approximately consistent with the classical diffusion coefficient of xenon in UO_2 modified by trapping effects. (auth)

12479 (RD/B/N-2375) EFFECT OF FLOW ON MASS TRANSPORT OF AN ADSORBING, RADIOACTIVE SPECIES IN A POROUS MEDIUM. Rodliffe, R. S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sep 1972. 11p. (RPC/M3FPR/P-(72)23; RPC/CA/N-(72)15). Dep. NTIS (U. S. Sales Only).

The equations describing the conservation of mass in a cylindrical pore are given for a decaying radioactive species being transported by diffusion and convection in the gas in the pore, by diffusion along pore walls, and undergoing adsorption–desorption at walls. An approximation is made which enables the equations to be solved analytically. The solution is evaluated for a range of parameters. (auth)

12480 EFFECT OF SURFACE-ACTIVE SUBSTANCES IN INTERMETALLIDE CRYSTAL GROWTH. Malinovskii, R. R.;

Tararyshkin, V. I. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 112-14(1972). (In Russian).

Certain metals lower the surface tension in alloy mixtures, e.g., Mg or Na can effectively modify the structure of intermetallic crystals of Al alloys with Fe and Co. A number of experiments were conducted on the addition of Na or Mg to $CrAl_7$, VAl_7, and Al–2% V, in order to ascertain the effect on the length of crystals of the intermetallides. Mg contents of 0.2 to 1.4 weight %, and Na contents of 0.012 to 0.048 weight % effective operated as modifiers of the crystallization process. (K.S.W.)

12481 EFFECT OF TUNGSTEN ON THE LAVES PHASE STRUCTURE IN THE Co–Nb–W SYSTEM. Varli, K. V.; D'yakonova, N. P.; Orlova, N. V.; Umanskii, Ya. S. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 115-17(1972). (In Russian).

The phase composition and alloy structure for four sections of the Co–Nb–W system were studied. Increase in the average electron structure during alloying with W of the Co_2Nb led to a structural change from cubic ($MgCu_2$ type) to hexagonal ($MgNi_2$ type) (Laves phase). Meanwhile the quantity of W required for alteration of the Co_2Nb structure decreased during an increase in the Co content in the phase. Decrease in the lattice constants of the phases Co_2Nb and Co_3Nb during alloying with W was caused by the replacement of Nb atoms by W atoms. (K.S.W.)

12482 REACTION OF LEAD AND LEAD–BISMUTH ALLOY WITH FUSED CALCIUM CHLORIDE THAT CONTAINS ZIRCONIUM. Vasin, B. D.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 102-3(1972). (In Russian).

The reactions of Pb and Pb–Bi alloy (50 weight %) with $CaCl_2$ containing Zr were studied at 800 and 1050°C. The distribution of Zr was determined. Roughly ⅓ was found in the residue at the bottom of the reaction crucible, ⅓ on the surface of the anode in the form of a slime, and ⅓ formed as a sublimate of volatile $ZrCl_4$. An insignificant fraction remained dissolved in the electrolyte at 800°C, and none remained at 1050°C. (K.S.W.)

12483 REACTION OF LEAD–BISMUTH ALLOYS WITH CHLORIDE MELTS CONTAINING URANIUM TETRACHLORIDE. Vasin, B. D.; Nichkov, I. F.; Raspopin, S. P.; Surikov, V. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 104-5(1972). (In Russian).

Lead–bismuth alloy was maintained in contact with NaCl–KCl which contained UCl_4 at 700, 750, and 880°C in order to ascertain the fate of the UCl_4 in the presence of the alloy as a reducing agent. Analyses of the fused salts showed that Pb dissolved, to form Pb^{2+}, with concomitant reduction of the U^{4+} to U^{3+}. The Bi did not enter into the reaction. (K.S.W.)

12484 GROUPS IV, V, AND VI TRANSITION METALS AND COMPOUNDS. PREPARATION AND PROPERTIES. Connolly, T. F. (ed.). Solid State Physics Literature Guides. Volume 3. New York; Plenum Publishing Corporation (1972). 221p. $14.50.

Two review articles on preparation methods for Groups IV, V, and VI transition metals and recent developments in the study of oxides are included. The scope of the bibliography is that of the Research Materials Information Center; emphasis is on materials preparation, ultrapurification, crystal growth, characterization, and basic physical properties of research specimens. The one exception to the coverage indicated by the title is the inclusion of Groups VII and VIII in the section on chalcogenides. References are given mainly to journals and reports on preparation methods, assay methods, structure, surface structure, electric properties, electronic structure, magnetic properties, optical properties, physical properties, elastic properties, melting points, phase transformations, and specific heat, thermal conductivity, and thermal expansion of Groups IV, V, and VI transition metals; transition metal borides; transition metal carbides; binary transition metal nitrides; material, preparation, and crystal growth, structure, phases, thermal properties, magnetic properties, electric and electronic properties, and optical properties of binary transition metal oxides; and binary transition metal chalcogenides. (P.C.H.)

12485 LIQUID METALS: CHEMISTRY AND PHYSICS. Beer, S. Z. (ed.). Monographs and Textbooks in Material Science. Volume 4. New York; Marcel Dekker, Inc. (1972). 741p. $35.00.

Fifteen chapters are included on: thermodynamic formalism of metallic solutions; kinetics of evaporation of various elements from liquid Fe alloys under vacuum; relation between thermodynamic and electric properties of liquid alloys; surface tension of liquid metals; significant structure theory applied to liquid metals; diffraction analysis of liquid metals and alloys; optical properties of liquid metals; effect of pressure on properties of liquid metals; sound propagation in liquid metals; viscosity of liquid metals; magnetic properties of liquid metals; diffusion in liquid metals; electromigration in liquid alloys; electronic nature of liquid metals and liquid metal theory; and structure and properties of noncrystalline metallic alloys produced by rapid quenching of liquid alloys. Separate author, subject, and systems indexes are included. (P.C.H.)

12486 THERMAL EXPANSION OF ZIRCONIUM. 2. Memon, C. S.; Ramji Rao, R. (Indian Inst. of Tech., Madras). J. Phys. Chem. Solids; 34: No. 1, 77-84(Jan 1973).

The generalized Gruneisen parameters $\gamma' = -\partial \log \omega/\partial\epsilon'$ and $\gamma'' = -\partial \log \omega/\partial\epsilon''$ have been calculated for various normal mode frequencies using the force model for zirconium obtained on Keating's approach (Phys. Rev; 145: 637(1966) and 149: 674(1966)). There is a general agreement between the normalized frequency distribution curve of zirconium obtained on the present model and that of Bezdek et al. (Phys. Status Solidi; 42: 275(1970)). The temperature dependence of the effective Gruneisen functions $\overline{\gamma}_\perp(T)$ and $\overline{\gamma}_\parallel(T)$ has been calculated using the procedure of Blackman (Proc., Phys. Soc. Lond.; B70: 827(1957)). The high temperature limits of $\overline{\gamma}_\perp(T)$, $\overline{\gamma}_\parallel(T)$ and γ_v are in good agreement with those obtained by Goldak et al. (Phys. Rev.; 144: 478(1966)) from an analysis of the thermal expansion data of zirconium. (auth)

12487 PRECIPITATION PROCESS ON AGEING OF Mg–Ce ALLOY. Omori, Goro (National Research Inst. for Metals, Tokyo); Matsue, Shigeru; Asada, Hiroshi. J. Jap. Inst. Metals; 36: No. 10, 1002-8(Oct 1972). (In Japanese).

The aging characteristics of quenched Mg–1.3 wt % Ce alloy were studied by electron microscopy and hardness measurement. On isothermal aging at 150°C, precipitates appeared first on the grain boundaries and dislocations at an early stage and precipitation within grains followed a little later. On aging at temperatures higher than 200°C, precipitation on the grain boundaries, dislocations and within grains took place simultaneously at an early stage. The diffraction effect observed suggests that the precipitates formed and dispersed uniformly within the matrix at an early stage of aging were to be of an intermediate phase in which cerium atoms might be enriched on $(10\bar{1}0)$ planes of the matrix. On a later stage of aging, the precipitates transformed into the equilibrium hexagonal phase of β, ribbon shaped, with the following orientation relationship with the matrix; $(0001)_M \langle 11\bar{2}0\rangle_M \,||\, (0001)_P \langle 10\bar{1}0\rangle_{P'}$, $c_M \approx c_P$, $3d_{(11\bar{2}0)M} \lesssim d_{(10\bar{1}0)P}$. The ribbon shaped precipitates grew mainly in the direction of $\langle 0001\rangle$ and, in much less extent, in the direction of $\langle 11\bar{2}0\rangle$ of the matrix. Significant age hardening observed in the present alloy should be associated with the precipitation of fine particles dispersed uniformly in the matrix. A certain amount of the intermediate precipitates appeared to remain even on a stage on which the maximum hardness was attained. An activation energy for age hardening process was determined to be 30 kcal/mole. (auth)

12488 SODIUM-NaK ENGINEERING HANDBOOK. VOLUME I. SODIUM CHEMISTRY AND PHYSICAL PROPERTIES. Foust, O. J. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1972). 337p. (TID–26008).

Prepared under the auspices of the Division of Reactor Development and Technology Division, USAEC.

The Sodium-NaK Engineering Handbook will be issued in five volumes. Volume I is entitled "Sodium Chemistry and Physical Properties" and contains information on conversion factors and nomenclature; general discussion of sodium, potassium, and NaK; mechanical properties; thermophysical properties; electric, nuclear, and miscellaneous properties; chemistry of the alkali metals; and chemical behavior of sodium and NaK with emphasis on the interactions of these metals with the elements. An appendix is included that gives supplemental analytical methods for determination of impurities in alkali metals. The remaining volumes of this handbook (to be issued) are as follows: Volume II, Sodium Flow, Heat Transfer, Intermediate Heat Exchangers, and Steam Generators; Volume III, Sodium Systems, Safety, Handling, and Instrumentation; Volume IV, Sodium Pumps, Valves, Piping, and Auxiliary Equipment; and Volume V, Sodium Purification, Material, Heaters, Coolers, and Radiators. (R.C.K.)

12489 MIGRATION OF BOUNDARIES AND INTERGRANULAR SLIPPAGE AT WELDED SEAMS OF SOLID SOLUTIONS OF NICKEL WITH NIOBIUM AND ALUMINUM. Loseva, G. I.; Chernyshova, T. A. Fiz. Khim. Obrab. Mater.; No. 2, 107-9 (1972). (In Russian).

The extent of grain boundary migration and intergranular slippage was quantitatively estimated in the structure of a welded metal joint of solid solutions of Ni with Al and Nb. With increase in the concentration of solid solutions the slippage along the grain boundary and boundary migration decreased. Nb tended to suppress these processes to a greater degree than Al. (tr-auth)

12490 INTERNAL ENERGY DISPERSION IN SINTERED COMPOSITES OF DIFFERENT DENSITIES IN THE Mo–Cu SYS-

TEM. Krishtal, M. A.; Golovin, S. A.; Rostovtsev, N. M.; (and others). Fiz. Khim. Obrab. Mater.; No. 2, 143-7(1972). (In Russian).

The damping properties of Mo–Cu composites were studied, with the result that a high level of internal dispersion of energy in such materials was found to be due to the presence of empty vacancies in Cu, microplastic deformation, and the degree of dispersion of copper occlusions. Porosity and filler had a considerable effect on the damping of vibrations in the composite sintered materials. The studies were made over a range of temperatures from 20 to 900°C. (K.S.W.)

12491 FORMATION OF A HARDENED LAYER DURING ELECTRIC SPARK ALLOYING. Samsonov, G. V.; Verkshoturov, A. D.; Repkin, Yu. D. Fiz. Khim. Obrab. Mater.; No. 2, 110-14(1972). (In Russian).

Some regularities in the formation of a hardened layer in the process of electric spark alloying were examined. Metals of Groups IV through VI of the Periodic System were tested as cathodes in the process: Zr, Ti, Nb, Ta, W, Mo, Cr, V, and Co. For electrode materials which form only limited solid solutions, the optimum processing time for each 1 cm^2 area should not exceed 2 to 3 min. For metals which readily form solid solutions, the processing time varies, but should not be greater than 5 to 6 min. The metals under test were arranged in the following order relative to the ease of transfer of anode material to the cathode: W-Mo-Ta-Nb-Zr-Ti-Cr-V-Co-Ni. (K.S.W.)

12492 KOMPOZITSIONNYE MATERIALY BOLOKNISTOGO STROENIYA. (Composite Materials of Fibrous Structure). Bobryshev, I. G. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1970). 404p.

The first half of the monograph is devoted to the theory of various aspects of composite materials, e.g., stability, elasticity, polymers, heat conductivity, microstructure, wave transmission, and reinforcement properties. The remainder of the book is concerned with the technology and application of fibers and reinforcing materials, plastics, filters, transpirators, packing and sealing materials, and methods of producing such objects. Compositions frequently referred to in this section include, in addition to the more common metals, ThO_2, Mo, W, ZrO_2, Nb, In, and Al–Ti, Al–Cr, and Al–Zr alloys. The later chapters are abundantly supplied with references. (K.S.W.)

12493 SPLAVY TSVETNYKH METALLOV. (Alloys of Non-Ferrous Metals). Bochvara, A. A. Moscow; Izdatel'stvo Nauka (1972). 248p.

This collection of papers on non-ferrous alloys by various authors was released in celebration of the 70th birthday of Academician A. A. Bochvar. A list of the papers by Bochvar from 1925 to 1969 is appended. Methods for improving the quality of refractory metals and their alloys are concerned with Mo, W, and Nb. Yttrium alloys are discussed with regard to the effect of deformation on their mechanical properties. Lattice structures, melting points, and Young's moduli of refractory metal carbides are considered in one paper, e.g., the carbides of Ti, Zr, Hf, V, and Nb. Metastable beta-alloys of Ti that contained Cr, Mn, V, Nb, Mo, and Ta were examined as a class. Magnetic alloys for high-temperature operation were the topic of one article which focused attention on Mg–Sc–Y–Mn mixtures. The damping properties of light alloys generally containing Al, Zn, Zr, and Mg were also explored. Alloys of Ni–Re, and Al–Be, and their phase composition diagrams are discussed. (K.S.W.)

12494 PRECIPITATION AND PRECIPITATION HARDENING IN NIOBIUM–ZIRCONIUM ALLOYS. Weinstein, A. M. Brooklyn; Polytechnic Inst. of Brooklyn (1972). 139p. University Microfilms Order No. 72-28,303.

Thesis.

The precipitation products and the hardening response was studied in a series of niobium–zirconium alloys containing from 37 to 92 atomic % Zr. Alloys were prepared in a button arc melting furnace from triply zone refined niobium and singly zone refined reactor grade zirconium. Tensile specimens of alloys containing 61.1% Zr, 65.6% Zr, and 91.8% Zr were solution-treated at 1150°C, quenched and subsequently aged for one hour at various temperatures ranging from 100 to 500°C. They were then tested in an Instron testing machine at a strain rate of approximately 1.2×10^{-4} sec^{-1} at ambient temperature. The resultant load-elongation diagrams suggest two distinct temperature ranges of precipitation. One is a range in which the ratio of the yield strength to the ultimate tensile strength approaches unity as the aging temperature is increased; another in which the yield strength remains considerably lower than the ultimate strength. The first temperature range corresponds to the decomposition of supersaturated β into the metastable ω and enriched β phases. The second range corresponds to the transformation of the equilibrium α and β phases. The transition temperature from range I to range II was taken as the $\beta/\omega + \beta$ transus temperature. The transus temperature for a 37.9% Zr alloy was investigated using x-ray diffraction of solution treated, quenched, and aged discs. The temperature at which ω reverted to β was determined and this was taken as the $\beta/\omega + \beta$ transus temperature for this alloy. One alloy, having the equiatomic composition, was studied using both tensile tests and transmission electron microscopy. Specimens were solution treated at 1150°C, quenched and aged at 225°C for times ranging from 15 minutes to 96 hours. The transmission electron microscopy samples were prepared by chemically thinning .006 in. thick sheet until it reached .001 to .002 in. in thickness. This was followed by electropolishing in a perchloric acid–ethanol electrolyte. No athermal or "diffuse" omega was observed for a solution treated and quenched sample. At least two other transition phases were found to exist in this alloy during the isothermal decomposition of the supersaturated solid solution. One is a face-centered cubic phase having $a_{fcc} = a_\beta\sqrt{2}$. The other is a body-centered tetragonal phase. The tensile results in the equiatomic alloy revealed three distinct maxima in the yield strength as a function of aging time. These were found to be consistent with the presence of the omega phase, the other two transition phases, and the equilibrium phases. The tensile results on all the alloys indicated that the isothermal omega phase is not necessarily an embrittling agent in Nb–Zr. This was especially true for the equiatomic alloy which contained the omega phase and exhibited both a high yield strength and good ductility. (Diss. Abstr. Int., B)

12495 BASAL SLIP IN ZIRCONIUM. Akhtar, A. (Univ. of British Columbia, Vancouver). Acta Met.; 21: No. 1, 1-11 (Jan 1973).

Single crystals of Zr have been deformed in tension between 295–1113°K with a range of orientations. First order prismatic slip continues to be the easiest slip mode, although the relative ease of basal slip increases with temperature. Extensive basal slip is observed above 850°K in orientations unfavorable for prismatic slip, whereas twinning precedes slip at lower temperatures. Non-basal slip vectors and slip planes other than $\{0002\}$ and $\{10\bar{1}0\}$ were not detected at any temperature within the range of orientations investigated. The critical resolved shear stress for basal slip was found to be temperature and strain rate dependent. An equation of state of the form $\dot{\gamma} = B_1^n \exp(-Q/kT)$ with a stress exponent equal to 3.48 and an activation energy of 1.48 eV was obeyed. It is proposed that the mechanism of basal slip involves recombination of extended dislocations lying on the prism planes followed by cross slip. On the basis of this model a partial dislocation spacing of 11b on the $\{10\bar{1}0\}$ planes is obtained, which is in good agreement with an earlier estimate of the stacking fault energy from the mechanics of prismatic slip. (auth)

12496 ORIENTATION DEPENDENCE OF ELASTIC PRECURSOR DECAY IN SINGLE-CRYSTAL TUNGSTEN. Michaels, T. E. Pullman, WA; Washington State Univ. (1972). 188p. University Microfilms Order No. 72-31,287.

Thesis.

Decay of the elastic precursor was studied for propagation along $\langle 111\rangle$, $\langle 110\rangle$, and $\langle 100\rangle$ crystallographic directions in single-crystal tungsten. Specimens were impacted with 6061-T6 aluminum projectiles and shock profiles were measured using quartz gages. Propagation distances studied ranged from 0.5 to 4 mm, and initial impact stress was nominally 80 kilobars. The orientation dependence of precursor amplitudes was analyzed using a constitutive relation developed in this study to describe dynamic yielding of single-crystal tungsten. With this theory, calculations show data support operation of known quasi-static slip systems in tungsten during shock compression. This study shows dislocation multiplication is important during shock compression of tungsten. Profile calculations were made, and larger than measured initial dislocation density is required in order to approach measured precursor decay rates when multiplication is suppressed. If multiplication is included, measured decay rates are matched, proper orientation dependence of precursor amplitude is predicted, and realistic wave profiles are generated. (Diss. Abstr. Int., B)

12497 STRUCTURE OF INDIUM–THALLIUM MELTS WITH 80 AT. PERCENT THALLIUM. Romanova, A. V.; Il'inskii, A. G. (Inst. of Metal Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 135-7(Jan 1972). (In Russian).

The structure of a Tl–In alloy with 80 at. % Tl was investigated in the liquid state at 270 and 300°C by x ray analysis. A complex structure of maximum intensity was detected. Analysis of the scattering intensity curve, and of the distribution curves of the atoms in the liquid and solid states, showed that the structure of liquid melt of Tl-20 at. % In at 270 and 300°C consisted of a microregion with short range order of a different type. In some microfields with a statistical distribution of atoms of both kinds a pack-

ing of the bcc lattice type occurred; in others, a hexagonal lattice, probably associated with the orienting influence of thin oxide films. (tr-auth)

12498 ABSOLUTE THERMOELECTROMOTIVE FORCE IN LIQUID METALS. Mikhailovskii, B. I.; Khar'kov, E. I. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 63-70(Jan 1972). (In Russian).

Measurements of absolute thermoelectromotive forces are presented for pure liquid metals. The values of the thermoelectromotive forces are suggested to be used for calculating matrix elements of pseudopotentials of pure liquid metals with scattering vector value $k = 2k_F$ (k_F is a wave vector of electrons on the Fermi surface). Measurements were made at 400°C with the liquid metals Zn, Cd, In, and Ga; and at various temperatures (30 to 800°C) with the liquid metals Zn, Cd, Al, In, Ga, Sn, Pb, and Bi. (auth)

12499 FRACTURE TOUGHNESS OF MATERIALS. Hahn, G. T.; Kanninen, M. F.; Rosenfield, A. R. (Battelle Labs., Columbus, OH). Annu. Rev. Mater. Sci.; 2: 381-404(1972).

Methods for evaluating the fracture toughness of materials using applied mechanics and materials science are reviewed. Discussions are included on strain-energy release rate, stress intensity factors, atomic structure, crack-tip plasticity, and crack extension mechanisms. (J.R.D.)

12500 EFFECTIVE INTERIONIC POTENTIALS AND PROPERTIES OF MOLTEN METALS. Waseda, Yoshio; Ohtani, Masayasu (Tohoku Univ., Sendai). J. Jap. Inst. Metals; 36: No. 10, 1016-25(1972). (In Japanese).

The Born–Green equation has been analyzed numerically to derive the effective interionic potentials from the structural data observed by x-ray or neutron diffraction experiments for molten metals (alkali metals, Mg, Zn, Hg, Al, Ga, In, Tl, Sn, Pb, Sb, and Bi) using a linearized simultaneous equation method. In all the cases the temperature insensitive long-range oscillatory type potentials were found. The damping-behavior of the oscillations for molten Sb and Bi remarkably deviated from that for the usual metals such as Na. For most of the metals the wavelength of the oscillations observed was moderately in good agreement with that expected from the electron theory of metals. The self-diffusion coefficient, viscosity coefficient, and surface tension were calculated using the effective interionic potentials obtained in this work. Adequate agreement with experiments was found. (auth)

12501 EXPERIMENT ON THE MECHANICAL ANISOTROPY OF TITANIUM, ZIRCONIUM, AND ZIRCALOY-2 ROLLED SHEETS. Okubo, Tadatsune (Tokyo Univ.); Tanabe, Tatsuhiko; Matsubayashi, Yusuke. J. Jap. Inst. Metals; 36: No. 10, 967-72(Oct 1972). (In Japanese).

The mechanical anisotropic properties of Ti, Zr, and Zircaloy-2 sheets have been measured under a uniaxial stress condition in the temperature range –196 to 300°C. The results obtained showed that the planar anisotropy of the proof stress and the flow stress at a small strain could be explained in consideration of the Schmid Factor. The invalidity of the Schmid Factor at large strain was due to anisotropy of work hardening. The n value and the uniform elongation of the specimen cut parallel to the rolling direction were always larger than those of the specimen cut parallel to the transverse direction, except in the case of Zr at –196°C. But the reduction of width at the point of fracture behaved conversely. It seems that the occurrence of deformation twinning at –196°C led to the highest value of uniform elongation and n value in Ti sheets under the condition tested, and also to the linear relation between stress and strain. (auth)

12502 HEAT CAPACITY AND ELECTRICAL RESISTIVITY OF SOME LANTHANIDE–NICKEL ($LnNi_5$) COMPOUNDS BETWEEN 5 AND 300°K. Marzouk, N.; Craig, R. S.; Wallace, W. E. (Univ. of Pittsburgh). J. Phys. Chem. Solids; 34: No. 1, 15-21(Jan 1973).

Results of heat capacity measurements for $LnNi_5$ compounds with Ln = La, Ce, Nd and Gd are presented for the temperature range 5 to 300°K. Electrical resistivities are given for the Ce, Nd and Gd compounds over the same temperature range. The heat capacities are consistent with the previously observed magnetic behavior of $LaNi_5$, $CeNi_5$ and $NdNi_5$. The La compound is a Pauli paramagnet and its heat capacity behavior is that of a solid exhibiting only vibrational and electronic excitation. $CeNi_5$ remains paramagnetic to 4°K and its C_p behavior closely resembles that of $LaNi_5$. $NdNi_5$ exhibits a λ-type thermal anomaly peaking at 6.4°K, which is ascribed to the break-up of ferromagnetism. It also shows excess heat capacity at higher temperatures resulting from excitation in the crystal field spectrum. Results for $GdNi_5$ are unusual. Magnetic entropy is introduced over an anomalously wide range of temperature. The process culminates in two λ-type thermal anomalies peaking at 29.8 and 30.6°K, suggesting that the development of the cooperative phase occurs in two stages. The magnetic transformations are also evident in the resistivity-temperature behavior of $NdNi_5$ and $GdNi_5$, the loss of the spin-disorder resistivity being readily apparent in the former material. The usual thermodynamic properties are computed from the heat capacity data. Magnetic entropies of $NdNi_5$ and $GdNi_5$ at 300°K are observed to be 95 and 86 per cent, respectively, of $R \ln(2J + 1)$. (auth)

12503 PROPERTIES OF SOME MOLYBDENUM BASE ALLOYS UNDER HELIUM HIGH TEMPERATURE CONDITIONS. Mueller, E. O. (Brown, Boveri und Cie AG, Mannheim, Ger.). pp 55-62 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

The emphasis is on metals for high-temperature gas turbine applications. In this connection Mo is probably the best metal, and commercial alloys with Ti or Ti and Zr additions show very high strength at temperatures of 800 to 1200°C, but oxidation resistance is poor. This difficulty does not arise, however, under inert environmental conditions such as He. A need was apparent, however, for reliable long-time creep data, in view of the fact that gas turbines have to be built for long-service life. More information was also required on ductility, notch sensitivity, and possible embrittlement after long high-temperature exposure conditions. Tests to study these factors were made. From the data obtained it was concluded that the use of these alloys for the blading of closed-cycle gas turbines in connection with a He-cooled high temperature reactor seems a promising application. The low notch sensitivity of the alloys at high temperatures cannot be changed by metallurgical methods, but might be controlled by suitable production methods, including optimized conditions for work hardening. Suitable design of components should also help to take advantage of the high creep strength of these alloys. (UK)

12504 ASYMMETRY IN SLIPPING IN METALS. Garber, R. I.; Mikhailovskii, V. M.; Mikhailovskii, I. M. Fiz. Metal. Metalloved.; 33: No. 5, 1097-1100(May 1972). (In Russian).

Autoion-microscopic analyses were made of the dislocations in acicular specimens of tungsten of 99.9+% purity. Over 90% of the dislocations were split; splitting in the {110}, {211}, and {321} planes was observed. (K.S.W.)

12505 SELF DIFFUSION IN NICKEL–MOLYBDENUM AND PALLADIUM–MOLYBDENUM SYSTEMS. Ugaste, Yu. E.; Pimenov, V. N. (Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved.; 33: No. 5, 1034-9(May 1972). (In Russian).

The concentration and temperature dependencies of the coefficient of self diffusion were investigated in solid solutions in Ni–Mo and Pd–Mo systems. The character of the change in parameters of self diffusion with change in concentration was demonstrated. The results obtained were compared with data from the Ni–Cr and Pd–Cr systems. (tr-auth)

12506 INFLUENCE OF BORON ON THE STRUCTURE AND SOME PROPERTIES OF ELECTRON BEAM-MELTED MOLYBDENUM. Chernov, V. S.; Busol, F. I.; Lapitskaya, V. N.; Nam, B. P.; Kreimerman, G. I. Fiz. Metal. Metalloved.; 33: No. 5, 1008-18(May 1972). (In Russian).

The effects of small additions (to 0.1 wt %) of B on the structure and some mechanical properties of cast and deformed Mo which had been melted by an electron beam were studied. The B manifested a strong modifying action on the macro-, micro-, and substructure of the metal; it also promoted a refinement of the grain faces. Micro-alloying of Mo by B caused a significant increase in the ductility of the Mo, enhanced its stability, and raised its temperature of recrystallization. (tr-auth)

12507 SURFACE TENSION OF SOME EASILY FUSIBLE METALS IN THE SOLID STATE. Shebzukhova, I. G.; Khokonov, Kh. B.; Zadumkin, S. N. (Kabardino-Balkarian State Univ., Nalchik, USSR). Fiz. Metal. Metalloved.; 33: No. 5, 1112-13 (May 1972). (In Russian).

The surface tension of polycrystalline specimens of Sn, In, Pb, Bi, and Tl was measured by the "null" creep method, yielding the following values in dynes/cm: Sn = 673 at 215°C, In = 633 at 142°C, Pb = 560 at 309°C, Bi = 521 at 239°C, and Tl = 562 at 272°C. (K.S.W.)

12508 X-RAY ELASTIC CONSTANTS OF TITANIUM AND Ti–Al6–V4. Bollenrath, F.; Froehlich, W.; Hauk, V.; Sesemann, H. (Technische Hochschule, Aachen). Z. Metallk.; 36: No. 12, 790-4(Dec 1972). (In German).

Using a round film camera the x-ray elastic constants were determined on 5 lattice planes on titanium and on the hexagonal

phase of Ti–Al 6–V4. The results are approximately in agreement with the calculated data of P. D. Evenschor, W. Fröhlich and V. Hauk (Z. Metallkde. 62 (1971) 38). According to the large deviations of the measurements and the small anisotropy of titanium nothing can be said of the validity of one or the other of the assumptions of W. Voigt or A. ReuB nor of an influence of the texture. The average of the calculated data may be used to determine stresses. (auth)

12509 POSITION OF THE CRITICAL POINT OF THE ISOMORPHOUS $\gamma \rightleftharpoons \alpha$ PHASE TRANSITION IN CERIUM. Kutsar, A. R. (Inst. of Metal Science and Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 33: No. 5, 1104-8(May 1972). (In Russian).

The increment in volume for the transition $\gamma \rightleftharpoons \alpha$ in 99.72% Ce was determined by dilatometer and piezometric measurements at 26 kbar and over the temperature range 290 to 700°K. At 293°K and a pressure of 6.8 kbar the volume effect was 14.5%, and the slope of the phase equilibrium line was 24.5 degrees/kbar. These values were in agreement with earlier work. Extrapolating the volume effect to zero determined the coordinates of the critical point in Ce: 280°K, p = 14.5 kbar. The volume effect ($\Delta V/V$, %) decreased with increasing temperature, attaining a value of zero at about 480°K. (K.S.W.)

12510 ROTATING DRUMS OF MARAGING STEEL FOR CENTRIFUGAL SEPARATORS FOR URANIUM ENRICHMENT. Nishihara, M. (First Atomic Power Industry Group, Tokyo); Hosomi, K. FAPIG (Tokyo); No. 65, 43-8(May 1972). (In Japanese).

Maraging steel is highly excellent in physical and metallurgical properties, and it is also excellent in welding behavior. High-velocity revolution is required for centrifugal separators and there is a relation between rotating speed and stress acting on drums. High strength and other excellent properties are required for the drums. Trial production of the rotating drums with maraging steel has been carried out. Mechanical properties of the products and the manufacturing process were tested. High-velocity revolution tests of the drums were successfully completed. (Japan)

12511 POTENTIAL TITANIUM AIRFRAME APPLICATIONS. Witt, R. H.; Paul, O. (Grumman Aerospace Corp., Bethpage, N. Y.). pp 333-49 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

Isostatically pressed and vacuum-sintered titanium alloy preforms from various sources were forged using conventional, high-energy rate and isothermal forging processes. Elemental powders were primarily employed to obtain the Ti–6Al–4V composition in the preforms. Results of evaluation studies pertaining to the effects of materials and process variables on microstructure, mechanical properties, and electron-beam weldability are presented. Selection of powder composition and forging process for production of airframe-quality titanium alloy forgings has been demonstrated. Potential airframe applications, producibility, and economic considerations are discussed, based on the results of the above evaluation. (auth)

12512 PROCESSING OF HIGH-PERFORMANCE ALLOYS BY POWDER METALLURGY. Pelloux, R. M. (Massachusetts Inst. of Tech., Cambridge). pp 351-63 of Powder Metallurgy for High-Performance Applications. /Burke, J. J. (ed.). Syracuse, N. Y.; Syracuse Univ. Press (1972).

From Powder metallurgy for high-performance applications conference; Raquette Lake, NY. (31 Aug 1971). See CONF-710848.

Processing of high-performance alloys by powder metallurgy offers a means to eliminate segregation of alloy constituents and to minimize the size of the inclusions. Powder-metallurgy processing of oxide dispersion-strengthened alloys, nickel-base superalloys, and maraging steels is discussed and the mechanical properties of the P/M alloys are compared to the properties of the cast and wrought alloys. (auth)

12513 STRENGTHENING MECHANISMS IN NICKEL-BASE SUPERALLOYS. Curwick, L. R. Minneapolis; Univ. of Minnesota (1972). 178p. University Microfilms Order No. 72-27,852. Thesis.

The elastic moduli and the compressive yield behavior has been measured for $Ni_3(Al,X)$ alloy single crystals containing Nb, Ta, Ti, W, or Mo, and for Ni–Cr–X alloy single crystals containing Co, W, or Mo. From these results the critical resolved shear stress for slip has been determined over the temperature range from 25° to 1000°C. The $Ni_3(Al,X)$ yield behavior was interpreted on the basis of slip on two slip systems, {111} ⟨110⟩ and {100} ⟨110⟩. A modified exhaustion hardening model is proposed to account for the anomalous temperature dependence of the critical resolved shear stress for {111} ⟨110⟩ slip in these alloys. The effects of alloying on the {111} ⟨110⟩ CRSS and on the {100} ⟨110⟩ CRSS are consistent with the proposed model. The Ni–Cr–X yield behavior was interpreted on the basis of normal FCC lattice slip on the {111} ⟨110⟩ slip system. The effects of alloying on the {111} ⟨110⟩ CRSS were consistent with classical solid solution strengthening. The Copley and Kear dislocation dynamic model was used to theoretically determine the effect solid solution strengthening of the γ(Ni–Cr) matrix and γ' (Ni_3Al) particle has on the strength of a hypothetical nickel-base superalloy. Image force theory was applied to theoretically determine the effects of changing the modulus mismatch by alloying. The theoretical results, on the strengthening mechanism in nickel-base superalloys, are discussed in comparison to the known properties of commercial superalloys. (Diss. Abstr. Int., B)

12514 INVESTIGATION OF FILMS OF TANTALUM COMPOUNDS ON THE SURFACE OF ACICULAR SINGLE CRYSTALS OF TUNGSTEN. Garber, R. I.; Afanas'ev, V. I.; Levandovskii, B. I.; Pruger, Kh. I. (Kharkov State Pedagogical Inst.). Fiz. Metal. Metalloved.; 33: No. 4, 890-3(Apr 1972). (In Russian).

Ta was applied to the surface of needle crystals of W using an electron bombardment method in a vacuum, the thickness of the completed Ta films ranging from 50 to 300 Å. In contrast to the pure Ta structure (bcc lattice, 3.83 Å), the films of Ta obtained were characterized by an fcc lattice, with a parameter of 4.47 Å, corresponding to the isomorphous compounds TaO or TaC. The work function of the coated surface was 1.5 times greater than the work function of a pure W surface, suggesting that the coating consisted of a carbide. (KSW)

12515 INFLUENCE OF THE β-PHASE ON THE DUCTILITY OF TWO-PHASE TITANIUM ALLOYS. Pertsovskii, N. Z.; Shakhanova, G. V.; Brun, M. Ya.; Notkin, A. B. Fiz. Metal. Metalloved.; 33: No. 4, 887-90(Apr 1972). (In Russian).

Microstructural peculiarities of deformation of a series of different Ti alloys were examined which revealed the behavior of the β-phase during the deformation of two-phase Ti alloys. A typical composition was that of the BT9 alloy: Ti–6.5%Al–3.4%Mo–1.9%Zr. The presence of a β-phase in a given alloy lent a high degree of resistance to deformation of the samples. (KSW)

12516 SOLID SOLUTIONS OF Ti–V–O AND Ti–V–Al–O SYSTEMS. Kornilov, I. I.; Vavilova, V. V.; Maksimov, Yu. A.; Lyashchenko, A. B. (Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved.; 33: No. 4, 881-4(Apr 1972). (In Russian).

A series of Ti-based alloys were prepared so as to contain 2.5% V and from 0 to 0.5% O; half of the samples contained 3% Al. The dependence of Young's modulus on the oxygen content of these alloys indicated that the presence of oxygen up to 0.5% in Ti–V and Ti–V–Al alloys resulted in stronger bonds in ternary and quaternary α-solid solutions. (KSW)

12517 CHANGES IN TEXTURE OF NICKEL–BERYLLIUM ALLOYS DURING DEFORMATION, RECRYSTALLIZATION, AND AGING. Larikov, L. N.; Borimskaya, S. T. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 33: No. 4, 849-51(Apr 1972). (In Russian).

Texture experiments were conducted on 99.99% Ni and its alloys with 2, 10.5, 12.5, and 15% Be. Deformation of these alloy samples was accomplished by 90% rolling in one direction. Heat treatments for fixed time periods produced recrystallization and aging of the alloys which were controlled by microscope and x-ray studies of the structure. (KSW)

12518 STRUCTURAL CHANGES DURING THE DEFORMATION OF POLYCRYSTALLINE LOW-ALLOYED MOLYBDENUM. Vitorskii, Ya. M.; Zubets, Yu. E.; Kaverina, S. N.; (and others) (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 33: No. 4, 831-40(Apr 1972). (In Russian).

Structural changes in polycrystalline low-alloyed Mo were studied for a broad range of degrees of deformation (2 to 90%) in the temperature interval from 20 to 1,400°C. Such structural changes were contrasted with changes in various mechanical characteristics. The formation of a cellular structure during low-temperature deformation was elucidated. Essential differences in the mechanism of the formation of a cellular structure in early and final stages of deformation were discussed. (tr-auth)

12519 NICKEL DIFFUSION ON THE (110) SURFACE OF A SINGLE CRYSTAL OF TUNGSTEN BY THE MASS TRANSFER METHOD. Geguzin, Ya. E.; Kibets, V. I.; Makarovskii, N. A. (Kharkov State Univ.). Fiz. Metal. Metalloved.; 33: No. 4, 800-7(Apr 1972). (In Russian).

A variety of mass transfer methods applicable to the study of heterodiffusion on the surface are outlined, including the "moving boundary" method. Data on the diffusion coefficient of Ni on a W

surface and the activation energy involved were obtained by methods of two-dimensional coalescence and moving boundaries. The length of the diffusion path and the anisotropy of the diffusion coefficient of Ni on a W surface were also obtained. (tr-auth)

12520 STRUCTURE AND PROPERTIES OF VACUUM RHENIUM CONDENSATES. Belomyttsev, Yu. S.; Yaroshevich, P. Yu. Fiz. Metal. Metalloved.; 33: No. 4, 758-62(Apr 1972). (In Russian).

The effect of the condensation temperature on the structure, microhardness, and the parameters a and c of Re condensates was studied. The condensation temperature was allowed to range from 400 to 1,500°C in a vacuum $\sim 2 \times 10^{-6}$ mm Hg, and substrates of Re and Mo were tested. The anisotropy of the microhardness in the condensates was explained. (tr-auth)

12521 THEORY OF ISOMORPHOUS TRANSITION IN BINARY CERIUM-BASED SYSTEMS. STABLE STRUCTURAL DIAGRAMS. Aptekar, I. L.; Yurichev, I. A. (Inst. of Solid State Physics, Moscow). Fiz. Metal. Metalloved.; 33: No. 4, 683-9(Apr 1972). (In Russian).

This is a companion paper to a treatment of Ce "pseudoternary" solid solutions (p. 675 of this issue of FMMEA) by the same authors. From a study of the stable equilibria in the region of isomorphous phase conversions it was shown that it was necessary to distinguish critical points of isomorphic metastable equilibria K_1 from critical points of stratification K_2. For finite values of the model parameters, the line of points K_1 on the T–P–C phase diagram is always found inside the region of homogeneity and may not strictly be coincident with a single point of the K_2 line. The possibility of a large variety of types of stable phase diagrams is explained, and their evolution with a change in model parameters is traced. (tr-auth)

12522 THEORY OF ISOMORPHOUS TRANSITION IN BINARY CERIUM-BASED SYSTEMS. METASTABLE PHASE DIAGRAMS. Aptekar, I. L.; Yurichev, I. A. (Inst. of Solid State Physics, Moscow). Fiz. Metal. Metalloved.; 33: No. 4, 675-82(Apr 1972). (In Russian).

Binary Ce alloys may be represented as pseudoternary solid solutions of trivalent Ce, tetravalent Ce, and an alloying element. Possible types of metastable T–P–C phase diagrams which describe an equilibrium of isomorphous phases of identical composition are discussed. The four simplest types depend on the parameters of the model. The calculated results are compared with existing experimental data on isomorphous conversions in the systems Ce–Th, Ce–Pu, and Ce–rare earth elements. (tr-auth)

12523 INFLUENCE OF SURFACE STATE AND TITANIUM FILMS ON THE DISLOCATIONAL STRUCTURE OF NEAR-SURFACE LAYERS OF MOLYBDENUM SINGLE CRYSTALS. Amonenko, V. M.; Shapoval, B. I.; Azhazha, V. M.; Kovtin, G. P.; Bondarenko, N. P. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 34: No. 2, 385-9(Aug 1972). (In Russian).

The formation of a distorted surface layer of a Mo single crystal was studied by a method of amplitude-dependent internal friction. The depth of the layer, the degree of enlargement of the dislocation density, and their interactions were investigated. The effects of thin Ti films on the surface of Mo and the mechanisms involved are discussed. (tr-auth)

12524 STRESSES DETERMINING THE VELOCITY OF HIGH-TEMPERATURE CREEP OF SINGLE CRYSTALS WITH A BODY-CENTERED CUBIC LATTICE. Kononenko, V. A.; Epik, O. P. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 34: No. 2, 402-7(Aug 1972). (In Russian).

The distribution of stresses in the {110}, {211}, and {321} planes during creep in metals with a bcc lattice was examined. The axes of stress were oriented differently in the samples with respect to their lattices. During high-temperature creep, slip may occur simultaneously along certain planes, but the creep velocity depends on the level of stress in these planes. Experimental data are adduced on creep in Mo single crystals with stress axes close to [011] and [111] at 1,360°C. (tr-auth)

12525 INTERNAL FRICTION OF ALLOYS Nb–Zr–N AND Nb–Hf–N. Elyutin, V. P.; Maksimov, D. G.; Mozzhukhin, E. I. (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved.; 34: No. 2, 412-15(Aug 1972). (In Russian).

The effects of Zr and Hf on the Nb–N reaction in single-phase solid solutions of Nb–Zr–N and Nb–Hf–N were studied by method of internal friction. All alloys tested contained 1 or 2% Zr, or 1 or 2% Hf and were prepared by high-purity arc melting the metals, with subsequent cold-rolling of the billet to a thickness of 0.1 mm. The samples were specially treated in a nitrogen atmosphere at 1,700°C. The temperature dependence of the internal friction of the alloys was measured over the temperature range 50 to 650°C. Without the additive (either Zr or Hf) present, only one peak (350°C) characterized the binary Nb–N system. The addition of Zr or Hf produced a second peak, at 465 and 495°C, respectively. The N was believed to react in part with the Nb atoms, and in part with the Zr(Hf) atoms. (KSW)

12526 INFLUENCE OF EXTENT OF DECOMPOSITION OF SOLID SOLUTION OF ZIRCONIUM IN ALUMINUM ON THE RECRYSTALLIZATION TEMPERATURE OF Al–Zn–Mg–Zr ALLOY. Elagin, V. I.; Zakharov, V. V.; Levin, L. I.; Moshkina, V. N. Fiz. Metal. Metalloved.; 34: No. 2, 421-4(Aug 1972). (In Russian).

The temperature of the beginning and end of recrystallization of a hot-pressed strip of Al–Zn–Mg–Zr alloy was investigated as a function of the annealing time at 500°C by means of x-ray and metallographic analyses. A decomposition of the supersaturated solution of Zr in Al occurred with the formation of spherical particles of Zr intermetallide. With increased annealing time the diameter of these particles continuously increased. The less the average distance between such particles, the greater was the temperature at the beginning and end of recrystallization. (KSW)

12527 HYDROGEN SELF-DIFFUSION IN THE SYSTEM Nb–Zr–H. Khodosov, E. F.; Kuryshko, V. I. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 34: No. 2, 424-6(Aug 1972). (In Russian).

The NMR spectra of various compounds in the Nb–Zr–H system were determined at −160° and +24°C as a function of the composition of the alloy. The behavior of the NMR spectra was interpreted in terms of changes in the concentration of separate phases (hydrides of a solid solution of Nb in Zr, and accordingly of Zr in Nb) in the region of two-phase compounds (~2 to 85% Nb) of the ternary system. Changes in the widths of NMR lines were associated with diffusion mobility of hydrogen. (KSW)

12528 PHASE TRANSFORMATIONS IN QUENCHED TITANIUM ALLOY VT9 DURING HEATING. Tomsinskii, V. S.; Ivanov, A. S. (Perm Polytechnic Inst., USSR). Fiz. Metal. Metalloved.; 34: No. 2, 429-31(Aug 1972). (In Russian).

The decomposition process of martensite α''-phase in the Ti alloy VT9 was investigated by high-temperature x-ray diffraction techniques. Samples of the alloy (6.7% Al, 3% Mo, 2.5% Zr, 0.22% Si) were quenched from 1000°C in water, then heated at a rate of 10°/min to 900°C in a vacuum. The decomposition of the α''-phase was complete at 600°C with a rearrangement of the $\alpha'' \rightarrow \beta$ phase. (KSW)

12529 INFLUENCE OF HYDROGEN ON THE INTERNAL FRICTION IN MOLYBDENUM. Kodes, E. S.; Syrykh, L. M.; Ryabov, R. A.; Gel'd, P. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Fiz. Metal. Metalloved.; 34: No. 2, 431-3(Aug 1972). (In Russian).

The temperature and amplitude dependence of internal friction of Mo wire (diameter 0.5 mm) were determined before and after saturating it with hydrogen. Hydrogenation of the Mo (to 10 cm^3/100 g Mo) caused an increase in the internal friction at all temperatures investigated (40 to 600°C), and thus behaved qualitatively analogous to deformation by elongation of the Mo. (KSW)

12530 FREQUENCY DEPENDENCE OF MECHANICAL VIBRATIONAL DAMPING IN SOME METALS OF TECHNICAL PURITY. Zolotukhin, I. V.; Abramov, V. V.; Tkachenko, T. V.; Postnikov, V. S. (Voronezh Polytechnic Inst., USSR). Fiz. Metal. Metalloved.; 34: No. 2, 438-40(Aug 1972). (In Russian).

The internal friction of a series of polycrystalline metals of industrial purity was investigated in the frequency range 60 to 10,000 Hz. The metals, whose chemical composition was accurately known, were identified as copper, nickel, Armco iron, zirconium, niobium, molybdenum, tantalum TV41, rhenium, tungsten, and titanium VT1-0. All samples were annealed at 800°C for one hour. Damping of the vibrations increased with increase in frequency. (KSW)

12531 SOME PRESSING CHARACTERISTICS OF MOLYBDENUM WIRE (FIBERS). Pochkai, G. N.; Rybal'chenko, M. K.; Samsonov, G. V. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 6, 437-40 (Jun 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 6, 10-14(Jun 1972).

Chopped Mo wire fibers 30, 50, 60, 70, 80, 90, and 120 μ in dia with average lengths of 3 or 10 mm were used in studies of pressing behavior of such materials. The wires were either in work-hardened or annealed condition. Study results revealed that the residual porosity of compacts as a function of compaction pressure is described by an exponential relationship. The apparent density of the wires was found to rise linearly with increase in their diameter and to fall with increase in their length. (JRD)

12532 PROPERTIES OF POROUS NICKEL–MOLYBDENUM AND NICKEL–CHROMIUM–MOLYBDENUM ALLOY MATERIALS. Solonin, S. M.; Chernyshev, L. I.; Fedorchenko, I. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 6, 456-60(Jun 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 6, 36-41(Jun 1972).

Results of studies made on the properties of porous permeable materials made from Ni–30Mo and Ni–15Cr–15Mo alloys are summarized. Data are included and discussed on porosity, mechanical properties, shear strength, and corrosion reactions with HCl. (JRD)

12533 TOWARD IMPROVED DUCTILITY AND TOUGHNESS. International Conference Held at Kyoto, Japan, October 25–26, 1971. Tokyo; Climax Molybdenum Development Company (Japan) Ltd. (1971). 366p. (In Japanese and English). (CONF-711052).

Twenty articles are included; a separate abstract was prepared for each of two. The remaining 18 articles contain information on: significance of ductility and toughness in terms of atomic processes of deformation and fracture; effects of composition and microstructure on ductility and toughness; criteria of ductility and toughness for fracture-safe design; toughness and effective grain size in heat-treated low-alloy high-strength steels; temper embrittlement of low-carbon alloy steels; effect of transformation structures on toughness of quenched and tempered low-carbon low-alloy steels; low-carbon bainitic steel with high strength and toughness; Mn–Mo–Nb acicular ferrite steels with high strength and toughness; low-temperature brittleness of Fe and steels; thermomechanical treatment of steels; microstructure and mechanical properties of ausformed steels; ductility enhanced by martensitic transformation in metastable austenitic Fe alloys; ductility of age-hardenable martensitic Fe alloys; effects of primary carbides on toughness of high-speed tool steels; effects of composition on ductility and toughness of ferritic stainless steels; embrittlement of high-strength steels by hydrogen absorption; delayed fracture by atmospheric embrittlement and microstructure; and delayed failure of high-strength steels. (P.C.H.)

For abstracts of individual papers see: 12534 and 12562.

12534 DUCTILITY IMPROVEMENTS IN SUPERALLOYS. Dunn, R. G.; Sponseller, D. L.; Dahl, J. M. pp 319-40 of Toward Improved Ductility and Toughness. Tokyo; Climax Molybdenum Development Co. (Japan) Ltd. (1971).

From Conference on toward improved ductility and toughness; Kyoto, Japan (25 Oct 1971). See CONF-711052.

Some recent developments concerning ductility improvements in superalloys are discussed. Particular emphasis is placed upon ductility or workability improvements that are achieved without sacrificing elevated-temperature strength properties. Because of the economic and technological impact that the aircraft gas turbine exerts on the superalloy industry, the ductility improvements are specifically directed toward aircraft engine applications. Two of the developments involve hafnium alloying and directional-solidification effects on cast-superalloy ductility properties. The two remaining developments relate to ductility and workability improvements in wrought superalloys and involve a discussion of thermomechanically processed and powder-metallurgy components. (auth)

12535 INVESTIGATION OF THE COMBUSTION BEHAVIOR OF LIQUID SODIUM. Huber, F.; Menzenhauer, P.; Peppler, W.; Tell, W. (Kernforschungszentrum, Karlsruhe, Ger.). KFK Nachr.; 4: No. 3, 9-13(1972). (In German).

The main purpose of the experiments was to record by a series of films and pictures of the most important procedure, namely the burning sequence in rooms, the restriction of the fire and also the elimination of the remaining sodium and sodium oxide residues. In this context the appearance of the form in which the fire can occur varies, e.g., surface burning, spurting fire, or burning of a pipe line. The best method of restriction was also examined. (GF)

12536 RESIDUAL STRESSES DETERMINED BY X-RAYS ON UNIAXIAL PLASTICALLY DEFORMED TITANIUM AND TiAl6V4. Bollenrath, F.; Froehlich, W.; Hauk, V.; Schlieper, P. (Technische Hochschule, Aachen). Z. Metallk.; 36: No. 12, 794-6 (Dec 1972). (In German).

Test pieces of titanium and Ti–Al6–V4 were plastically deformed by tension and the lattice parameters measured by x-rays on 4 lattice planes in different directions to the perpendicular of the surface. The residual stresses were calculated. They are at least as large as those resulting from strain hardening. They become larger with the deformation. The hexagonal metals show the same properties as cubic metals. (auth)

12537 X-RAY ELASTIC CONSTANTS OF ZIRCONIUM. Hauk, V.; Ott, W.; Sesemann, H. (Technische Hochschule, Aachen). Z. Metallk.; 36: No. 12, 796-8(Dec 1972). (In German).

Investigations to calculate and to measure x-ray polycrystalline elastic constants of hexagonal metals, e.g., zirconium are reported. The data were determined from measurements on 3 lattice planes and are in relatively good agreement with the calculated data in respect to the small accuracy of the measurements due to the small yield point. An influence of the heavy texture is not to be expected due to the small anisotropy of zirconium. (auth)

12538 CALCULATION OF X-RAY ELASTIC CONSTANTS FROM SINGLE CRYSTAL COEFFICIENTS OF HEXAGONALLY CRYSTALLIZING METALS. Evenschor, P. D.; Hauk, V. (Technische Hochschule, Aachen). Z. Metallk.; 36: No. 12, 798-801(Dec 1972). (In German).

The x-ray polycrystalline elastic constants were calculated from the data on single crystals of hexagonal metals based on the assumptions by J. Eshelby, E. Kröner, and G. Kneer. (auth)

12539 CREEP AND STRESS-RUPTURE MECHANISMS OF MOLYBDENUM AND ITS ALLOYS. Zasimchuk, E. E.; Kriveniuk, V. V. (Inst. of Safety Problems, Kiev). Probl. Prochnosti; 4: 33-37(Jun 1972). (In Russian).

Plane 1-mm thick samples of industrial-grade molybdenum (99.97% Mo), a molybdenum-base alloy with 0.14% Zr, and a molybdenum-base alloy with 0.075% Zr, 0.18% Ti, 0.003% C, 0.004% O_2, 0.0004% N_2, and 0.0003% H_2, prepared by hot rolling and annealing at 1400°C, were tested. Plots of the creep limit vs. temperature and time-to-rupture, of the steady creep rate vs. stress and temperature, and of the temperature coefficient vs. stress are presented and discussed. The influence of microalloying on the creep and stress-rupture characteristics is examined. (IAA)

12540 MECHANICAL PROPERTIES OF TITANIUM STRENGTHENED BY MONODIRECTIONAL MOLYBDENUM WIRES. Karpinos, D. M.; Tuchinskii, L. I.; Gorb, M. L.; Umanskii, E. S.; Fefer, V. Ya. (Inst. of Problems in Materials Studies, Kiev). Probl. Prochnosti; 4: 28-32(Jun 1972). (In Russian).

The test samples were prepared by dynamic hot pressing in vacuum from 0.8-mm titanium plates wound with 0.8-mm molybdenum wire. The volume content of the wire was 10, 20, 32, and 44%. It is found that the coefficient of strain hardening increases substantially with increasing temperature. The influence of the volume content and the winding angle on the notch toughness is determined. (IAA)

12541 INFLUENCE OF STRESS CONCENTRATION ON THE MECHANICAL CHARACTERISTICS OF MOLYBDENUM AT NORMAL AND ELEVATED TEMPERATURES. Zeneniuk, E. E.; Rudenko, V. N. (Inst. of Safety Problems, Kiev). Probl. Prochnosti; 3: 96-99(Dec 1971). (In Russian).

Tensile tests with molybdenum samples having helical and circular grooves, performed in vacuo at temperatures between 20 and 1500°C are described. Samples with circular grooves were found to behave in the same manner as smooth samples, whereas samples with helical grooves (as compared to smooth samples) experienced reductions in strength by 10 to 40% within the range of test temperatures. It is suggested that, under comparable test conditions, molybdenum becomes sensitive to the higher stress concentrations produced by helical grooves. (IAA)

12542 DIAGRAMMY SOSTOYANIYA TROINYKH METALLICHESKIKH SISTEM, 1910–1969 gg. BIBLIOGRAFICHESKII SPRAVOCHNIK. (Ternary Phase Diagrams of Metal Systems, 1910–1969. A Bibliography). Ageev, N. V. (ed.). Moscow; Izdatel'stvo Nauka (1972). 192p.

Literature references are provided for 1693 ternary metal systems and cover the world's literature from 1910 to 1969. The alphabetical listing is based on the Russian orthography, although a subject index based on international symbols is available. This bibliography has drawn heavily on J. L. Haughton's "Constitution of Alloys Bibliography," London, J. Inst. Metals, 1956. (KSW)

12543 ACOUSTIC ANISOTROPY OF METALLOCERAMIC (SINTERED METAL POWDER) MOLYBDENUM MOLDINGS. Kobyakov, O. S.; Petushkov, E. E. pp 104-6 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The axial ($C_{||}$) and radial ($C_{\perp}$) velocities of longitudinal ultrasonic vibrations in Mo were determined before and after pressing, sintering, welding, forging, and drawing. Results showed absence of anisotropy in the pressings ($C_{||} = C_{\perp}$ = 1500 to 1700 m/s); sintering has no effect on anisotropy, although there is a jump in velocity to 3200 to 3600 m/s. After welding, the velocity increases again, to 4650-5800 m/s, with an anisotropy of $C_{||}/C_{\perp} > 1$. Forged and drawn samples show increasing velocity (6000 to 6290 m/s) and continued anisotropy. (DLC)

12544 MOSAIC STRUCTURE OF MOLYBDENUM SINGLE CRYSTALS. Alimova, R. N.; Klein, G. A. pp 110-13 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The mosaic structure of Mo single crystals grown by electron-beam melting was studied using Laue x-ray topography and a metallographical microscope. The disorientation of the second-order blocks was 0°10′ to 0°15′. An integral curve consisted of two peaks with a disorientation of 0°20′ between them and a half-width of ~0°50′. (DLC)

12545 CHANGES IN THE STRUCTURE OF MOLYBDENUM SINGLE CRYSTALS SUBJECTED TO THERMAL FATIGUE. Krakhmalev, V. A.; Klein, G. A. pp 114-17 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The dynamics of dislocation changes in the early stages of thermal fatigue (thermal cycling) was studied using two different heating–cooling treatments. Results show very substantial changes in crystal structure, with eventual complete polygonization. (DLC)

12546 STUDY OF CERTAIN MACROSCOPIC DEFECTS IN REFRACTORY METALS. Klein, G. A.; Krakhmalev, V. A. pp 131-7 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp.(1971).

Mo, Mo–Zr, and Th-containing W were studied in a transmission electron microscope, using a single-stage replica method. Pores in Mo, impurity precipitates in Mo, and precipitates in Th-containing W wire were studied. (22 references) (DLC)

12547 PRODUCTION AND PROPERTIES OF ORIENTED SINGLE CRYSTALS OBTAINED FROM MOLYBDENUM POWDER. Klein, G. A.; Mikhailov, S. M.; Osipova, L. Kh.; (and others). pp 138-41 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A study was made of the physicomechanical properties of oriented Mo single crystals after pressing, annealing in H, and electron-beam zone melting. The crystals had different tensile strengths and ductilities, with the maximum strength occurring for the [111] single crystals and the greatest ductility for the [112] and [110] directions. The distribution of the deformation over the length of a [112] single crystal was determined. From Laue x-ray photographs of crystals with [110] and [112] axes, slip occurs along two perpendicular systems of planes of the {110} type in the ⟨111⟩ direction. (DLC)

12548 PHYSICOMECHANICAL PROPERTIES OF DEFORMED MOLYBDENUM SINGLE CRYSTALS. Klein, G. A.; Mikhailov, S. M.; Osipova, L. Kh.; (and others) pp 142-4 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A study was made of the changes occurring in the tensile strength, ductility, and microstructure of [100], [110], and [111] Mo single crystals deformed to various degrees by forging and wire drawing. Deformation strengthens Mo, especially in the [110] direction and least for the [100] direction. The smallest ductility occurred for [111] single crystals. The microstructure showed that a shear motion took place over the slip planes; slip bands were visible for the [110] and [111] directions, but not for [100]. 90% deformation resulted in a fine-grained polycrystalline aggregate. Results indicate a direct relation between degree of deformation and strengthening. (DLC)

12549 PIPPARD'S RELATIONS AND THE ORDERING REACTION IN Mg_3Cd. Bartis, F. J. (Indiana Univ., Bloomington). Scr. Met.; 6: No. 12, 1223-6(Dec 1972).

The initial and final stages of ordering in Mg_3Cd were examined. An elementary thermodynamic method was used to show that the continuous stages of ordering are characterized by the same Pippard relations. Pippard's thermodynamic relations are used to describe the three stage ordering reactions found in Mg_3Cd. (JRD)

12550 CONSTITUTION OF THE COPPER–INDIUM–TIN SYSTEM IN THE RANGE FROM 100 TO 50 AT. PERCENT Cu. Koester, W.; Goedecke, T.; Heine, D. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 36: No. 12, 802-7(Dec 1972). (In German).

The constitution of the copper–indium–tin system was investigated up to 50 at. % Cu. 14 four-phase equilibria occur, 11 of them among phases in the solid state. At 585°C a ternary peritectoid leads to the formation of a paramagnetic phase $Cu_{11}SnIn_2$. The α, β, and η phases form continuous solid solutions between the copper–tin and copper–indium systems. The phases γ_1, γ_2, ζ, ϵ, and δ_2 exhibit a large solubility for the third components δ_1 a small solubility for indium. The phases β, γ_1, γ_2, and δ_1 decompose eutectoidically. The binary high temperature phase ζ is stabilized at room temperature by the addition of indium. (auth)

12551 THERMODYNAMIC PROPERTIES OF MOLTEN ALLOYS IN THE SYSTEM URANIUM–LEAD. Lebedev, V. A.; Poyarkov, A. M.; Nichkov, I. F.; Raspopin, S. P. This paper was summarized in At. Energ. (USSR); 31: No. 6, 621-622(Dec 1971) as paper No. 546/6213. (In Russian).

Full copy of this paper is held by TIC.

Measurements were taken of the emf of galvanic batteries of type U_{solid}/fused electrolyte +5 wt % UCl_3/U–Pb_{liquid}, over the temperature range from 660 to 870°C. The results of the measurements were reduced to a single standard state (γ-uranium). The emf between the uranium and saturated solutions of uranium in molten lead was independent of the uranium content in the alloys (5 to 15 wt %) and independent of the electrolyte composition (KCl–NaCl or KCl–LiCl based melts), but varied with temperature according to the equation: $E = 0.403 - 0.251 \cdot 10^{-3}T \pm 0.002$ V. Partial enthalpies and the entropy of γ-uranium in the compound UPb_3, an equilibrium composition with the saturated solutions, were constant over the range of temperature studied, and were respectively -27.9 ± 1.4 kcal/g · atom and -17.4 ± 1.4 esu/g · atom. For the partial free energy of uranium in that compound, the following equation would be valid: $\Delta\bar{G}_U = -27.900 + 17.4 \cdot 10^{-3}T \pm 0.3$ kcal/g · atom. Using the data so obtained, as well as the information on uranium solubility in lead the thermodynamic properties of uranium solutions in molten lead can be determined. The activity coefficient of the uranium in these solutions, with respect to γ-uranium, varies with the temperature according to the equation: $\lg \gamma_U = 2.977 - (2366/T) \pm 0.08$. When the state of molten uranium is taken as the standard state, the equation for the activity coefficient of the uranium (k_U) acquires the form $\log k_U = 3.717 - 3396/T \pm 0.08$. The dissolution of molten uranium in lead is accompanied by the release of a significant amount of heat (15.5 kcal/g · atom) and by a decline of 17.0 esu/g · atom in excess entropy, attesting to the formation of stable, ordered groupings of atoms of the solute with the solvent atoms in the metallic melt. Negative deviations from Raoult's law are typical of the low-temperature activity of uranium in solution, while positive deviations from Raoult's law are typical at high temperatures. The activity of molten uranium in uranium solid solutions with lead is close to the atomic fraction, at temperatures in the order of 900°K. (auth)

12552 CHEMICAL COMPOSITION OF MOLYBDENUM AND STEEL SURFACES FROM AUGER ELECTRON SPECTRAL DATA. Zashkvara, V. V.; Red'kin, V. S.; Korsunskii, M. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 46-8(1972). (In Russian).

The chemical composition of the surface of Mo strips which had an initial purity of 99.9% was evaluated by Auger electron spectroscopy. A similar spectrum was obtained for steel. The process involved heating to a high temperature in a hard vacuum. (tr-auth)

12553 RECRYSTALLIZATION IN Ti–15 Mo BASE BETA TITANIUM ALLOYS. Ohtani, Shitoshi; Nishimura, Takashi; Nishigaki, Minoru (Kobe Steel, Ltd., Japan). J. Jap. Inst. Metals; 36: No. 11, 1105-10(Nov 1972). (In Japanese).

The precipitation site of alpha, which is related to the mechanical properties of the aged Ti–Mo-base beta alloys is, as previously reported, affected by the preceding solution-treatment. It seems that this phenomenon is related to the recrystallization behavior of the alloys. The effects of the preceding working and the solution-treatment on the precipitation site of alpha during aging were studied in Ti–15 Mo–5 Zr and Ti–15 Mo–5 Zr–3 Al alloys. The beta transus was determined using an optical microscope. By observing the structure after heat treatment at temperatures above or below the estimated beta transus, the precipitating or vanishing point was determined. Detection of a small quantity of alpha on the grain boundaries was difficult. Consequently the specimens in which alpha was uniformly precipitated in the grains by pre-aging, were examined. The beta transi of Ti–15 Mo–5 Zr and Ti–15 Mo–5 Zr–3 Al were 730 and 785°C, respectively. Two steps of recrystallization were observed in the alloys. Alpha precipitated non-uniformly during aging even in the specimens in which most of the deformed grains were changed to equiaxed ones in the initial stage of recrystallization. The fact that alpha precipitated in some grains and not in others is due to the incompleteness of the recrystallization. Alpha precipitated preferentially on the grain boundaries after the final stage of recrystallization. The relation between the temperature and the time of the two stages of recrystallization is summarized in a diagram. The final stage recrystallization temperature was affected by the preceding deformation conditions. (auth)

Radiation Effects

Refer also to abstracts 11711, 12401, and 14019.

12554 (AD-744941) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report,

February 1–April 30, 1972. Steel, L. E.; Smidt, F. A. Jr.; Sprague, J. A.; Shahinian, P.; Watson, H. E. (Naval Research Lab., Washington, D. C.). 15 May 1972. 46p. (NRL-MR-2441). NTIS.

The research program involves a broad study of the effects of nuclear radiation upon materials. The report, covering research for the period 1 February–30 April 1972, includes: electron microscopy observations of radiation damage in pressure vessel steels and iron alloys; the effects of neutron irradiation on fatigue crack propagation in austenitic stainless steel at high temperature; a study of radiation reduction in notch toughness of stainless steel submerged arc weldments; the effect of cyclotron-injected helium on the fatigue properties of 316 stainless steel; and preliminary results from an environmental exposure of candidate CTR first-wall structural alloys. (auth)

12555 (AD-747950) EFFECT OF NEUTRON IRRADIATION ON FATIGUE CRACK PROPAGATION IN TYPES 304 AND 316 STAINLESS STEELS AT HIGH TEMPERATURE. Final Report. Shahinian, P.; Watson, H. E.; Smith, H. H. (Naval Research Lab., Washington, D. C.). 21 Jul 1972. Contract AT(49-5)-2110. 19p. (NRL-7446). NTIS.

The resistance of pre- and postirradiated AISI Types 304 and 316 stainless steels to fatigue crack propagation was determined at 800 and 1100°F (427 and 593°C) using the fracture mechanics approach. The effects of irradiation on the fatigue resistance of these steels were dependent upon test temperature and irradiation conditions. (auth)

12556 (BNWL-1576) EFFECT OF IRRADIATION LEVEL ON THE RUPTURE TEMPERATURE OF ZIRCALOY-2 CLAD URANIUM FUEL TUBES. Reid, D. L.; Hesson, G. M. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1971. Contract AT(45-1)-1830. 40p. Dep. NTIS.

For Douglas United Nuclear, Inc., Richland, Wash.

Declassified 1 May 1972.

An abbreviated study was scoped to determine the expansion of Zircaloy-2 cladding as a function of temperature for highly irradiated, N-Reactor, outer fuel elements subjected to loss-of-coolant thermal transients. The experiments revealed a rather sharp and major reduction in the slope of the rupture temperature curve for fuels between 0.5 and 0.65 at. % burnup. Observations with fuels above and below 0.5 at. % BU are related to internal gas pressure and the strength and ductility of Zircaloy-2 cladding. The physical changes and microstructure of the uranium and Zircaloy-2 are shown and discussed. (auth)

12557 (KFK-1450) HIGH TEMPERATURE EMBRITTLEMENT. Closs, K. D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Jul 1972. 28p. (In German). Dep. NTIS (U. S. Sales Only).

A summary on high-temperature embrittlement is given. The basic mechanism is explained by means of the bubble model. As an example, the possibilities for influencing high-temperature embrittlement are discussed for the austenitic stainless steel with the number 1.4970. The helium generation in the BR2, SNR, and DFR reactors was calculated and compared for the steels number 1.4988 and 1.4970. The results, different He concentrations from cyclotron and reactor irradiations have on the amount of embrittlement, are examined for the stainless steel AISI 304. (auth)

12558 ELECTROCHEMICAL BEHAVIOR OF CHROMIUM–NICKEL STEELS AND THE INFLUENCE OF MARTENSITE SEGREGATION AND OF RADIATION DAMAGE ON STRESS CORROSION. Schreiber, F. Stuttgart; Stuttgart Univ. (1970). 49p. (In German).

Thesis.

The electrochemical behavior of $MgCl_2$ solutions, in particular the lid-coating, the damage of the lid-coating and its reformation with and without the process of crack formation, was investigated using the technical material X10CrNiTi189 and chromium–nickel alloys (Fe–19Cr–10Ni) with and without added molybdenum. The influence of the alloys composition, $MgCl_2$ concentration, temperature, and plastic deformation due to torsion was tested. The effects of the martensite formation, which depends on the composition of the alloy, the subcooling, and also the radiation damage by neutrons, on stress corrosion, obtained statements on the influence of dislocation orientation and dislocation defects. (GF)

12559 PECULIARITIES OF ANNEALING RADIATION DAMAGE IN SILVER AND COPPER THIN FILMS DURING PROTON BOMBARDMENT. Chechetenko, V. V.; Tishchenko, L. P.; Peregon, T. I.; Fogel, Ya. M. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 56-62(Jan 1972). (In Russian).

A study was carried out of isothermal annealing of paired defects in silver and copper films during a long time after irradiation. Two temperature intervals can be distinguished in the temperature range of the films from 93 to 263°K within which the processes of annealing the defects are different in quality: at temperatures from 153 to 233°K, a release of interstitial atoms from impurity traps and their recombination with vacancies or diffusion to outlets take place, and at temperatures from 233 to 263°K diffusion of vacancies or divacancies to outlets occurs. Peculiarities are discussed of radiative defect annealing in silver and copper films as compared with their annealing in massive metallic samples. (auth)

12560 EFFECT OF OXYGEN IMPURITY ON DEFECT AGGLOMERATION AND HARDENING OF NEUTRON-IRRADIATED NIOBIUM. Loomis, B. A.; Gerber, S. B. (Argonne National Lab., IL). Acta Met.; 21: No. 2, 165-72(Feb 1973).

The density and diameter distribution of defect clusters and loops in neutron-irradiated niobium containing either 10, 68, or 185 ppM (wt) of oxygen impurity was determined for neutron doses up to 4×10^{19} neutrons/cm^2. The data were correlated with the increase of resolved shear stress of irradiated niobium single crystals containing oxygen impurity. Based on a dispersed barrier hardening model, the hardening of niobium irradiated at 30 to 50°C was interpreted to be due primarily to loops and clusters with diameters less than 70 Å. (auth)

12561 EFFECTS OF HIGH NEUTRON EXPOSURES ON PROPERTIES OF MATERIALS. Nichols, F. A. (Bettis Atomic Power Lab., West Mifflin, PA). Annu. Rev. Mater. Sci.; 2: 463-500 (1972).

A review is presented of phenomena associated with neutron reactions in nonfissile alloys and metals at high temperatures. Discussions are included on radiation damage cascades, radiation growth, creep and fracture during neutron irradiation, stresses, and swelling by neutron-induced voids. (J.R.D.)

12562 EFFECT OF NEUTRON IRRADIATION ON THE TOUGHNESS AND DUCTILITY OF STEELS. Reuther, T. C.; Zwilsky, K. M. (Atomic Energy Commission, Washington, DC). pp 289-317 of Toward Improved Ductility and Toughness. Tokyo; Climax Molybdenum Development Co. (Japan) Ltd. (1971).

From Conference on toward improved ductility and toughness; Kyoto, Japan (25 Oct 1971). See CONF-711052.

The fundamental impact of neutron irradiation on metals is the displacement of atoms from normal lattice sites, the consequent generation of extensive lattice defect structures, and the production of impurity elements by transmutation reactions. The consequence of these irradiation produced changes is to alter the plastic flow and plastic instability behavior in highly specific ways depending upon the steel, its thermal, mechanical and irradiation history and the specific test conducted. In light of this fundamental perspective, current research and technology findings on the effect of neutron irradiation on engineering properties and behavior of steels for use in current and advanced reactor designs are reviewed. In particular, irradiation effects on the ferritic steels for pressure vessel application in light-water reactors and on the austenitic stainless steels for fuel cladding, structural, and vessel applications in sodium-cooled fast-breeder reactors are examined. In general both types of a steel exhibit an increase in hardness and tensile yield strength and a decrease in tensile ductility and fracture toughness with neutron exposure. The ferritic steels also show an increase in ductile-to-brittle transition temperature and the stainless steels exhibit a loss of ductility at elevated temperatures in both tensile and creep testing. It is shown that the susceptibility of both categories of steel to neutron irradiation damage can be reduced by careful attention to chemistry and/or microstructure. Data, models, and theories that examine the bases of these effects are cited. The extrapolation of irradiation test data to the prediction of material performance in other neutron flux and spectra environments are reviewed in terms of the damage function concept of the neutron energy dependence of observed property changes. The influence of irradiation embrittlement on deformation and failure mode are examined by example in the analysis of irradiated fuel pin performance. (auth)

12563 RADIATSIONNO-STIMULIROVANNAYA DIFFUZIYA V METALLAKH. (Radiation-Induced Diffusion in Metals). Shalaev, A. M. Moscow; Atomizdat (1972). 148p.

The majority of processes which occur in metals and alloys under the influence of ionizing radiation depend on the diffusion mobility of the atoms in the material. Changes in the mobility of atoms are observed both during irradiation and after it, and this book is devoted to these phenomena, radiation-induced defects, and the mechanisms involved in an increase in the mobility. Radiation-induced diffusion in ordered metal systems, and the influence of radiation on the decay processes of metastable solid solutions and on processes in non-equilibrium metallic systems are discussed. 285 references. (KSW)

12564 EFFECT OF NEUTRON IRRADIATION ON THE STRUCTURE AND MICROHARDNESS OF DIFFERENT FACES OF MOLYBDENUM SINGLE CRYSTALS. Grishkov, G. N.; Mavridi, D. I.; Klein, G. A. pp 118-20 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The effects of neutron irradiation on the microhardness were found to be appreciable for all directions except (111). Laue x-ray photographs showed spot splitting, indicating the diminution and disorientation of blocks. (DLC)

12565 RADIATION BLISTERING OF POLYCRYSTALLINE NIOBIUM BY HELIUM-ION IMPLANTATION. Das, S. K.; Kaminsky, M. (Argonne National Lab., IL). J. Appl. Phys.; 44: No. 1, 25-31(Jan 1973).

The radiation blistering of polycrystalline niobium surfaces at room temperature was investigated for different doses of helium ions implanted at 0.5 MeV and for different amounts of initial defect structure in the samples. The cold-worked samples show large blisters (up to 500 μm in diameter), many of which are ruptured. In samples annealed before irradiation, the blistering at low doses (0.1 C/cm^2) was lower than in the cold-worked sample, but at a higher dose (1.0 C/cm^2) the blistering was even greater. The observation of interconnecting bubbles offers a possible explanation for the formation of such large blisters at low temperatures. (auth)

12566 ACCELERATED IRRADIATION TESTS. RESEARCH AND DEVELOPMENT OF REACTOR MATERIALS IN THE FUTURE. Ishino, S. (Tokyo Univ.). Genshiryoku Kogyo; 18: No. 6, 33-8(Jun 1972). (In Japanese).

Fuel cladding materials for fast breeder reactors may be exposed to total fast neutron flux of 10^{23}/cm^2. Such high flux cannot be obtained easily by means of material testing reactors. Irradiation testing using accelerators, however, makes it possible to obtain irradiation equivalent to 10^{23} nvt/cm^2 in only a few hours. This method also allows testing to be done under clearly specified conditions of irradiation. It is a powerful means for research and development on reactor materials for fast breeder reactors and nuclear fusion reactors in the future. Formation of voids has been reported recently in many kinds of metals by the irradiation of high-fluence neutrons at high temperature. The accelerator irradiation test is a useful method in the research of this phenomenon. There is, however, some difference between irradiation effects by fast neutrons and charged particles. The phenomenon of void superlattice was found under some conditions of heavy irradiation. High-temperature irradiation embrittlement is also an important problem, which has been investigated by the injection of helium. There is some difficulty in simulating the effects of high-neutron flux on mechanical properties by the accelerator irradiation. Application of high-voltage electron microscopes to accelerator irradiation tests was attempted. (Japan)

Other Materials

Refer also to abstracts 11957, 12401, 12441, 12443, 13831, 13836, 13842, 13843, 13999, 14001, 14002, 14015, 14018, 14019, and 14287.

12567 (AEEW-M-1134) RE-ASSESSMENT OF MEASUREMENTS OF FAST NEUTRON DAMAGE IN GRAPHITE MADE IN DIDO AND BEPO. Barclay, F. R.; Griggs, C. F. (Atomic Energy Establishment, Winfrith (England)). Oct 1972. 16p. (RPC(GP)P-(72)23). Dep. NTIS (U. S. Sales Only).

The experiments of graphite damage in various neutron spectra have been analyzed in the past with Monte-Carlo methods. Although the different measurements have been demonstrated to be broadly consistent some discrepancies remained which were judged to be significant. This report describes work to try and reduce these discrepancies for the DIDO, PLUTO and BEPO reactors. Monte-Carlo calculations were made with SPECIFIC, as these give the best available treatment of the energy variable, but transport theory calculations were also made using WIMS as these are cheaper and avoid problems of statistical uncertainty. Broad agreement has been achieved between irradiations in DIDO/PLUTO hollow fuel elements and the BEPO T.E. 10 experimental holes, but some discrepancies remain for the hollow fuel pin experiments in BEPO. (auth)

12568 (AEEW-R-815) SPECIFIC HEAT OF GRAPHITE; AN EVALUATION OF MEASUREMENTS. Butland, A. T. D.; Maddison, R. J. (Atomic Energy Establishment, Winfrith (England)). Oct 1972. 22p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Measurements and evaluations of the specific heat at constant pressure for graphites in the temperature range 200 to 3500°K are reviewed. A polynomial fit to the data is made for use with nuclear graphite, valid over the range 250 to 3000°K. Some consideration is given to the difference between the specific heat at constant volume and at constant pressure. A measurement of the graphite phonon frequency spectrum at 1800°K is used to calculate the specific heat at constant volume, and then to modify slightly the polynomial fit to the constant pressure data. (auth)

12569 (BNL-14764) PREPARATION, PROPERTIES, AND POTENTIAL APPLICATIONS OF CONCRETE-POLYMER MATERIALS. Steinberg, M. (Brookhaven National Lab., Upton, N. Y.); Backstrom, J. E. (Bureau of Reclamation, Denver, Colo.). May 1970. 33p. (CONF-701027-3). Dep. NTIS.

From Conference on radiation and isotope techniques in civil engineering; Brussels, Belgium (28 Oct 1970).

Preformed mortar and concrete can be fully impregnated with monomer and polmerized in-situ by either gamma radiation or thermal-catalytic techniques. This latter material, hereafter called concrete-polymer, has been found to have substantially improved structural and durability properties compared with those of conventional concrete. The improvement in properties appears to be a function of the polymer loading. Maximum increases in strength are obtained by forming and curing the concrete, subsequent drying, evacuating, soaking the concrete in monomer, and initiating polymerizations in situ by ^{60}Co gamma radiation. Strength increases of up to four times the control specimens have been obtained. Water permeability, water absorption, and chemical attack by distilled water, sulfate, brines, and hydrochloric acid have been reduced to negligible values compared with severe attack observed on the control specimens. The thermoplastic monomers, methyl methacrylate, styrene, and chlorostyrene are of value for normal temperature applications. Crosslinked and thermosetting monomers such as 60% styrene-40% trimethylolpropane trimethacrylate, diallyl phthalate, polyester-styrene, and epoxy-styrene impregnated in concrete allow the maintenance of strength and durability properties up to temperatures in the order of 150°C. Radiation treated concrete-polymer results in strength properties that are from 12 to 38% higher than thermal catalytically treated material. There appears to be little difference between the effect of radiation and thermal treatment on the durability properties of concrete-polymer except that which can be attributed to polymer loading. Polymer impregnation significantly increases the bond strength and flexural strength of steel-reinforced concrete. Polymer impregnated concrete containing light weight aggregate such as expanded volcanic ash is increased in compressive strength by more than a factor of 9. Concrete-polymer is being considered for construction of corrosion resistant sewer pipe, drain pipe, building block, underwater structures, large multi-stage flash desalination plants, highway applications, and underground support systems. A preliminary comparison between concrete-polymer and other materials of construction indicate reasonable economic potential for certain applications. (auth)

12570 (LA-5123) CMB-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 21, Summary of Progress, February 1-April 30, 1972. Smith, M. C. (Los Alamos Scientific Lab., N. Mex.). Dec 1972. Contract W-7405-eng-36. 12p. Dep. NTIS.

Research and development on carbon and graphite were undertaken primarily to increase understanding of their properties and behavior as engineering materials, to improve the raw materials and processes used in their manufacture, and to learn how to produce them with consistent, predictable, useful combinations of properties. The approach taken is microstructural, based on study and characterization of natural, commercial, and experimental carbons and graphites by such techniques as x-ray diffraction, electron and optical microscopy, and porosimetry. Physical and mechanical properties are measured as functions of formulation, treatment, and environmental variables, and correlations are sought among properties and structures. Raw materials and manufacturing techniques are investigated, improved, and varied systematically in an effort to create specific internal structures believed to be responsible for desirable combinations of properties. Sections are included containing research progress on raw materials, modification of carbon structures using organometallic compounds, and factors affecting fabrication. (J.R.D.)

12571 (LA-DC-72-1404) FORMATION OF CARBIDE DISPERSIONS IN CARBONS USING ORGANOMETALLIC ADDITIONS. Imprescia, R. J.; Wewerka, E. M.; Reiswig, R. D.; Levinson, L. S. (Los Alamos Scientific Lab., N. Mex.). [nd]. 10p. (CONF-721054-1). Dep. NTIS.

From Symposium on special carbons; Albuquerque, NM. (25 Oct 1972).

Results are presented of experiments in which organometallic

compounds of Ti, Zr, V, and Ta were dissolved in either furfuryl alcohol resin or coal tar pitch and pyrolyzed to produce dispersions of carbides in carbon matrices. These dispersions can be commuted to produce carbide-loaded carbon fillers used in production of graphites. (JRD)

12572 BINARY SYSTEMS UCl_3–UF_4 AND UCl_3–ThF_4. Desyatnik, V. N.; Raspopin, S. P.; Trifonov, I. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 100-1(1972). (In Russian).

A study of the binary system UCl_3-UF_4 revealed the existence of two incongruently melting compounds: $2UCl_3 \cdot UF_4$ and $UCl_3 \cdot 7UF_4$, melting at 625 and 760°C, respectively. The eutectic at 42 mole % UCl_3 melted at 590°C. Another binary system, UCl_3-ThF_4, exhibited a congruently melting compound $UCl_3 \cdot ThF_4$ which melted at 820°C, and two eutectics. One eutectic, with 35 mole % UCl_3, melted at 715°C; the other with 76 mole % UCl_3 melted at 660°C. (K.S.W.)

12573 DEPENDENCE OF THE MECHANICAL PROPERTIES OF WOOD–PLASTIC COMPOSITES ON THE MIXTURE RULE. Taneda, K.; Hasegawa, I.; Kawakami, H. (Hokkaido Forest Products Research Inst., Japan). Mokuzai Gakkaishi; 17: No. 5, 181-7(Jun 1971). (In Japanese).

Vacuum- and air-dried basswood (Tilica japonica SIMONKAI) was impregnated with styrene and methyl methacrylate and then polymerized in situ by γ irradiation or catalyst-heat techniques. The composites and constituent materials were tested in static bending under an equilibrium condition, and untreated wood was also tested under dry conditions. Mechanical properties of the composites were modified to the dry condition based on the assumption of linear change of the wood component with moisture content. On the other hand, theoretical equations of rule of mixture were derived from an assumed model of the composites, and the theoretical and experimental values of the mechanical properties under the equilibrium and dry conditions were calculated. Although the latter, in general, was larger than the former in the equilibrium condition, the two values were observed to approach each other clearly in the dry condition except air-dried wood-polystyrene composite, in which wood component seemed to be plasticized by heat and moisture during polymerization. Under the dry condition good agreement was obtained in the case of the modulus of elasticity and the stress at the proportional limit except for the gamma treated composite, which had larger values for the properties than theoretical values, because of better properties of the polymer in the composite than that of polymer by catalyst-heat employed in the calculations as properties of plastics. In the case of the modulus of rupture (σ), in general, larger experimental values were obtained, for progressive effect appeared to be expected from the fact that σ of wood increased more (approximately 1.2 to 1.4th power) than the rate of increase of its specific gravity. Furthermore, the bending properties were appreciated mainly due to the wood component, and other portions were dependent upon plastics and some progressive effect as a result of apportionment of the properties to each constituent material. (auth)

12574 THERMOLUMINESCENCE OF A LUMINESCENT CRYSTAL WITH TWO CAPTURE LEVELS. Kudelin, K. M. Inorg. Mater. (USSR) (Engl. Transl.): 8: No. 6, 941-4(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.: 8: No. 6, 1073-6(Jun 1972).

A model of a thermoluminescent crystal phosphor with two trap levels is examined and the kinetic equations for this model are solved. On this basis the fact that as the radiation does increase the deep trap levels become more effectively filled by charge carriers is explained. (auth)

12575 PROPERTIES OF GLASS SURFACES. Ernsberger, F. M. (PPG Industries, Inc., Pittsburgh). Annu. Rev. Mater. Sci.; 2: 529-72(1972).

Methods for evaluating glass for use in critical applications are reviewed. Discussions are included on surface tension of solids, cleavage energy of glass, microstructure of glass, microfractures in glass surfaces, glass surface polishing, surface treatments, properties of float-surface glass, adsorption, and electric properties of glass surfaces. (J.R.D.)

12576 HIGH-TEMPERATURE GAS-SOLID REACTIONS. Rosner, D. E. (Yale Univ., New Haven). Contract DAH CO4-70-C-0027. Annu. Rev. Mater. Sci.; 2: 573-606(1972).

Rates of chemical reactions between solids and nonequilibrium gas mixtures are examined. The physical and chemical factors governing these reaction rates are also examined. Discussions are included on reaction regimes, reactions forming volatile products, reactions forming dissolved or condensed products, and simultaneous physical phenomena. (J.R.D.)

12577 IRRADIATION DAMAGE IN GRAPHITE. Kelly, B. T.; Brocklehurst, J. E.; Gittus, J. H. pp 17-28 of Graphite Structures for Nuclear Reactors. London: Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

After a brief historical survey of radiation damage, the basic mechanisms of damage in graphite are described, together with its effects, and the development of graphites with improved performance. 14 references. (UK)

12578 EXAMINATION OF THE FRACTURE BEHAVIOR OF GRAPHITE THROUGH THE USE OF SPLITTING TENSILE TESTS. Yahr, G. T.; Valachovic, R. S.; Greenstreet, W. L. (Oak Ridge National Lab., Tenn.). pp 29-46 of Graphite Structures for Nuclear Reactors. London: Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

Comparisons of results from tests conducted on splitting tensile specimens made from AXM and ATJ graphites with analytical predictions indicate that linear-elastic fracture mechanics methods can be used for predicting fracture of graphite under complex stress states. Circular and elliptical disks were tested under lateral, colinear, compressive loads, the forces being applied along a diameter of the circular disks and along the major axis of the elliptical disks. Elliptical disks with major-to-minor axis ratios of 1.5 and 2.0 were used. Predictions of failure loads were obtained through the use of finite element analysis methods in combination with linear-elastic fracture mechanics methods. (auth)

12579 GRAPHITE CORROSION IN MAGNOX REACTORS. Dominey, D. A.; Phelps, B. A. pp 47-58 of Graphite Structures for Nuclear Reactors. London: Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

A summary is given of the present state of knowledge of reactions between CO_2 and graphite in reactors, including the effect on these reactions of other gases normally present in the coolants of Magnox reactors, under the following headings: Graphite oxidation by CO_2; measurement of G(-C) in the laboratory; variation of G(-C) with coolant composition; effect of CO concentration on rate of corrosion of graphite; influence of H_2O; influence of CH_4; and comparison of laboratory with monitoring data. 24 references. (UK)

12580 GRAPHITE CORROSION IN ADVANCED GAS-COOLED REACTORS. Lind, R.; Lewis, H. G. pp 59-72 of Graphite Structures for Nuclear Reactors. London: Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The data required for the design of AGR cores are described, with particular reference to reaction with CO_2, the effects of methane concentration breakdown, and core attack assessments. It is concluded that while there are still areas in which design data could with advantage be amplified or confirmed, nevertheless sufficient information exists to enable the AGR design engineer to assess the cumulative core corrosion and to determine control requirements and technique. It is believed that the 1 vol % CO, 700 vpmCH_4, and 600 vpmH_2O coolant, tested in the Windscale AGR for about three years, will provide adequate core protection for the core of the CAGR currently under construction. 36 references. (UK)

12581 OBSERVATION ON THE FILAMENTARY GROWTH OF GRAPHITE. Wawner, F. E, Jr. (Univ. of Virginia, Charlottesville); deBolt, H. E. J. Appl. Phys.; 44: No. 1, 502-3(Jan 1973).

A study was conducted to show the dependency of the growth of graphite fibers on a metallic impurity. It was seen that heating carbon monofilament by striking a dc arc utilizing a tungsten electrode in a gaseous environment of Ar, N_2, and HCl led to the filamentary growth of graphite. If the tungsten electrode was replaced by a carbon one, fiber growth was not observed. Repeating these experiments after removing HCl from the gaseous environment showed no fiber growth in either case. It is proposed that the growth of the fibers can be attributed to HCl reacting with the tungsten to form WCl_6 which is reduced to tungsten on the carbon substrate serving as an impurity site. (auth)

12582 RADIATION DAMAGE IN GRAPHITE OVER A WIDE RANGE OF TEMPERATURES AND NEUTRON FLUX LEVELS. Klimenkov, V. I.; Zolotukhin, V. R. This paper was summarized in At. Energ. (USSR); 31: No. 5, 506-507(Nov 1971) as paper No. 536/6291. (In Russian).

Full copy of this paper is held by TIC.

The problem of how to impart dimensional stability to graphite in high-temperature reactors is of great practical interest at the present time. In the light of the demand for radiation-resistant graphites, it is sometimes sufficient to know what changes are likely to take place under certain sets of conditions in the graphite used, so that these changes can be taken into account in the design and development of reactors. Radioinduced changes in the dimensions of reactor graphite depend in a complex way on the irradiation temperature, considering the broad variety of processes taking place in the graphite and associated with radiation defects whose behavior must be studied over an extended range of temperatures and neutron flux levels. A concept of the generalized diagram of radiation-thermal changes in graphite volume is formed. A refined variant of the diagram is proposed, using all the available data to plot the diagram, including data obtained when irradiating specimens of polycrystalline graphite in the SM-2 high-flux reactor. Volume changes indicated in the diagram were calculated in terms of known changes in the linear dimensions in the direction perpendicular to and parallel to the axis of formation $\Delta v/v = 2(\Delta l/l)_{\perp} + (\Delta l/l)_{||}$, which is entirely valid as a procedure applied to such grades of isotropic graphite as Soviet graphite GMZ, ZOPG, PGG, the foreign Gilsocarbon, etc. On the diagram, the zero isochore $\Delta v/v = 0$ separates the regions in which the graphite experiences either swelling or shrinkage. Possible mechanisms underlying the phenomena occurring in the different regions are discussed. The fact that the diagram is not strictly quantitative in nature, owing to the complexity of the phenomena and the inadequacy with which they have been studied, is pointed out. (auth)

12583 RADIATION RESISTIVITY OF PLASTICS. Saechtling, H.; Zebrowski, W. pp 470-1 of Kunststoff-Taschenbuch. Munich; Hanser (1971). (In German).

A table of tensile strength and fracture strain data for various thermoplastics, duroplastics, and cellulose acetate after irradiation at 20°C under exclusion of oxygen (arbitrary dose rate) and in air (1 Mrad/h, 4,000 rad/h, and 400 rad/h) is presented. (GF)

12584 EXPERIMENTAL RESULTS OF THE IRRADIATION OF SOME SHIELDING CONCRETE SAMPLES FOR GAMMA AND NEUTRON–GAMMA RAYS MANUFACTURED USING ROMANIAN-MADE AGGREGATES AND BINDING MATTERS. Balanescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 8, 935-943(1972). (In Rumanian).

The results of irradiation experiments on concrete with baryta hydrate and on concrete with corundum, serpentine, and rare earths are described. Concrete samples of the above mentioned composition, were irradiated at average temperatures of 200 and 400°C with doses ranging from 8.1×10^{19} to 4.21×10^{20} n/cm^2, having an energy above 1 MeV. The irradiations were carried out at the reactor Melusine, Grenoble, using four special devices, each of them occupying half the size of a fuel element. The temperatures mentioned were obtained only by nuclear heating of the material. The probes of concrete with baryta hydrate were cylindrical 50 mm diameter, variable height, and the ones of concrete with serpentine were prismatic, having the size $30 \times 30 \times 30$ mm, and $40 \times 40 \times 160$ mm. (auth)

12585 RADIATION DAMAGE IN BROMINATED GRAPHITE. Kosai, A. (Miyazaki Univ., Japan); Fukumori, T.; Matunaga, K.; Hirabara, O. Miyazaki Daigaku Kogakubu Kenkyu Hokoku; No. 18, 85-90(Aug 1972). (In Japanese).

An investigation of radiation damage in graphite and brominated graphite was made through the observation of the changes in Hall coefficient and magnetoresistance at room and at liquid-nitrogen temperatures. The specimen examined is a pile-grade graphite bombarded with fast neutrons at 40°C to total dose of 1.34×10^{19} nvt. The values of magnetoresistance coefficient before irradiation were 1.78 and 1.89, respectively. These values after irradiation changed to 0.36 and 0.47, respectively. Further the coefficient of brominated graphite is inconsiderable. The sign and magnitude of the Hall coefficient apparently depend on the extent of exposure. Unirradiated graphite possesses an even negative Hall coefficient, but its sign after irradiation was reversed and the absolute value increases. Before irradiation the mobilities of conduction electrons and holes decreases with increase in atomic percentage of bromine, however, after irradiation the change is very small. The change of lattice constants and sizes of crystallite of brominated graphite under neutron irradiation were measured by the x-ray diffraction method. The values of C_0-spacing obtained from (004) profile were larger than those found for unirradiated graphite. The values increased slightly as the concentration of bromine increased. This fact suggests that the interstitial carbon atoms produced by the irradiation would be included in brominated graphite layers. On the other hand, the sizes of crystallite measured from (002) profile decreased by irradiation, but since (112) profile was observed, it was considered that the crystallite of brominated graphite had three dimensional structure. (auth)

12586 RADIATION DAMAGE IN PYROLYTIC CARBON. Kosai, A.; Fukumori, T. (Miyazaki Univ., Japan). Miyazaki Daigaku Kogakubu Kenkyu Hokoku; No. 18, 79-84(Aug 1972). (In Japanese).

An investigation of radiation damage in pyrolytic carbon (PC) and brominated PC was made through the observation of changes in electric resistivity, Hall coefficient and magnetoresistance at room temperature. The specimens examined were prepared by deposition on flat surfaces of commercial resistance furnaces to 1800, 2000, and 2200°C and bombarded with fast neutrons to a total dose of 3.05×10^{18} nvt. The values of magnetoresistance coefficient for PC before irradiation were 0.42 (1800°C), 1.65 (2000°C), and 1.79 (2200°C), respectively. The last value agrees very well with the one obtained by Kinchin (1953). These values after irradiation changed to 0.75, 1.03, 1.74, respectively. The Hall coefficient is positive in the range of between 1800 and 2000°C. The values of Hall coefficient after irradiation increase with the rise of deposition temperatures. The concentrations of conduction electrons and holes and their mobilities were calculated by the use of a two-band model. The values of conductivity of holes increase by irradiation, also the mobilities of conduction holes in the PC are larger than those of the electrons. (auth)

12587 DEPENDENCE ON COMPOSITION OF THERMAL DIFFUSION IN D_2–H_2, HD–H_2, AND D_2–HD AT 85°C. Mueller, K. P.; Klemm, A. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch.; 27a: No. 12, 1755-8(Dec 1972). (In German).

Measurements of the thermal diffusion factor (α) resulted in the relations D_2-H_2: $\alpha = (0.182 - 0.057\ \gamma) \pm 0.003$, $HD-H_2$: $\alpha = (0.116 - 0.036\ \gamma) \pm 0.003$, and D_2-HD: $\alpha = (0.064 - 0.017\ \gamma) \pm 0.002$ with γ the molar fraction of the heavy molecule. Earlier measurements on tritium systems were corrected and are discussed in view of these results. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 12000 and 12046.

12588 (BNFL-Report-83) PLUTONIUM ACCOUNTANCY IN COMMERCIAL TRANSACTIONS INVOLVING PLUTONIUM OXIDE. Swinburn, K. A. (British Nuclear Fuels Ltd., Risley (England)). 1972. 4p. Dep. NTIS (U. S. Sales Only).

A description of the sampling technique employed for commercial transactions involving plutonium oxide powder is provided, together with an assessment of the results obtained during the history of such transactions. The technique conveniently allows for weight changes in the oxide during transit thereby eliminating their contribution to the so-called "shipper–receiver difference." Using this method excellent agreement between supplier and receiver has been achieved. The mean difference between Windscale and all receivers has been 0.030% with a standard deviation of 0.18% abs. (auth)

12589 (CTC-INF-1043) ENVIRONMENT FOR DIRECT INPUT TO THE AEC NUCLEAR MATERIALS INFORMATION SYSTEM. Hyde, D. A. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [nd]. Contract W-7405-eng-26. 16p. (CONF-720529-6). Dep. NTIS.

From 13th annual meeting of the Institute of Nuclear Materials Management; Boston, MA (31 May 1972).

The nuclear materials information system developed and operated by the Nuclear Division of Union Carbide Corporation for the Atomic Energy Commission is described. The system is used by the AEC in managing and safeguarding nuclear materials. It processes, stores, and retrieves information on inventories, material balances, and transactions of nuclear materials applicable to domestic lincensees and contractors and on materials supplied to foreign countries for peaceful purposes under international agreements. On nuclear materials owned by the AEC, additional information is captured relative to the usage and the administrative, programmatic, and financial management of the materials. The design and operational features of the system are described, including the computer hardware and software components. The major emphasis is on the data systems and the events, procedures, and use of data transmission facilities to improve the timeliness characteristics of the data base. Recent activities in the development of direct input operations between facilities and the central data base are reviewed. (auth)

12590 (GULF-RT-A-12280) ^{252}Cf IN ISOTOPIC SOURCE ASSAY SYSTEMS FOR NUCLEAR MATERIALS. Final Technical Report. Costello, D.; Gallagher, W.; Gozani, T.; Kendrick, H. (Gulf Radiation Technology, San Diego, Calif.). 14 Nov 1972. Contract AT(38-1)-730. 74p. Dep. NTIS.

The principles and the performance of an Isotopic Source Assay System (ISAS) that uses ^{252}Cf as a source of interrogating neutrons are described. The ISAS determines, by active nondestructive neutron interrogation the amount of fissile material in an unknown sample relative to the fissile content of a similar, known sample. The same system can be used, but with less sensitivity, to determine the amount of fertile material in a sample by the performance of an additional measurement using a slowed-down-neutron spectrum. The ISAS consists of a source container and collimator assembly, a fission multiplicity detector, a sample carrier, and associated electronics. A collimated beam of neutrons emerges from the source container and causes fissions in the sample being measured. The resulting neutrons and gamma rays are detected by four plastic scintillators, and fission is distinguished from other reactions by the high multiplicity (~2.5 neutrons and 7 gamma rays) of the reaction products. A three-out-of-four coincidence within an ~60-ns time gate is normally used. In addition to operational data and evaluation, the parts and components of the assay system and their functions are described. Sources containing as little as 25 μg of ^{252}Cf can be used for measurements of tenth-gram to kilogram quantities of uranium or plutonium. Such sources are easily shielded and can be used in ordinary laboratory or fabrication facilities without creating a hazard for operating personnel. ^{252}Cf provides a practical means of quickly assaying such problem materials as heterogeneous bulk scrap, residues, calcined ash, and slag to a degree of accuracy (±1 to 2%) that has not been routinely achieved by other assay methods. Because of the relatively short time required per assay, the cost per assay is lower than most other methods of analysis. (RWR)

12591 (LA-5064) ANALYTICAL METHODS FOR FISSIONABLE MATERIALS IN THE NUCLEAR FUEL CYCLE. Program Status Report, June 1971–June 1972. Waterbury, G. R. (comp.) (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 9p. Dep. NTIS.

Progress is reported on the development of analytical methods for the determination of uranium and plutonium for nuclear safeguards application and the preparation of well-characterized plutonium-containing materials for laboratory evaluation purposes and as standards. A Teflon-container, metal-bomb apparatus has been developed for the dissolution of samples in acids, including hydrofluoric acid, at temperatures to 280°C and pressures to 5000 psi. Apparatus and conditions have been developed for assay of small amounts of ^{235}U by gamma counting with a NaI(Tl) detector. This system is being extended to the assay of ^{239}Pu. The development of an automated apparatus is nearing completion for the determination of uranium and plutonium by a selective extraction of these actinides into an organic phase and a spectrophotometric measurement of the extracted species in the organic phase. Samples of plutonium nitrate solution in sealed glass ampoules with measured plutonium contents and isotopic compositions were prepared for the Safeguards Analytical Laboratory Evaluation Program. One lot of highly pure plutonium metal chemical standards was prepared for shipment to the National Bureau of Standards. (auth)

12592 (LA-5078) APPLICATION OF THE RANDOM SOURCE INTERROGATION SYSTEM (RANDOM DRIVER) AT THE OAK RIDGE Y-12 PLANT. Preliminary Results. Foley, J. E. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 7p. Dep. NTIS.

Preliminary results of measurements made with the Random Source Interrogation System ("Random Driver") at the Oak Ridge Y-12 plant are presented. Samples of highly enriched uranium in 2-liter and larger containers have been assayed with the system. Results indicate that fast neutron interrogation, as opposed to thermal interrogation, is required for good penetrability of the samples. (auth)

12593 NEUTRON COINCIDENCE COUNTERS FOR NUCLEAR SAFEGUARDS APPLICATIONS. Foley, J. E. (Los Alamos Scientific Lab., NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 453-6(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Reliable, accurate, and rapid nondestructive assay instrumentation is playing an increasingly important role in the practical implementation of nuclear material safeguards, inspection, and surveillance as well as in quality control and operational safety in all types of nuclear processing facilities. The neutron coincidence counting technique was successfully demonstrated for nondestructive assay of samples containing Pu or U. The technique involves detecting neutrons from the spontaneous fission of ^{240}Pu and ^{238}U with polyethylene-moderated neutron coincidence counters containing ^{3}He- or BF_3-filled detectors surrounding the sample to be assayed. The coincidence counting technique is necessary for reliable assay since total neutron count rate is dependent not only on the amount of Pu in the sample but also on the chemical composition. For example, if the sample contains PuO_2, the total neutron production rate would be ~100 n/s-g; however, if the sample contained PuF_4, the total rate would be ~300 times larger than this. The spontaneous fission rate of both samples would be ~25 fiss/s-g (for 5% ^{240}Pu isotopic composition), independent of chemical composition. By using the coincidence counting technique it is possible to distinguish spontaneous fission neutrons from the randomly produced (α,n) neutrons. Thus, coincidence counting provides a powerful method for rapid and accurate assay of Pu-bearing samples. The use of fast plastic scintillation detectors has significantly extended the range of usefulness of the coincidence counting technique to materials with extremely high (α,n) activities. (auth)

Disposal and Storage

12594 (BNWL-SA-4450) LONG-TERM WASTE MANAGEMENT METHODS. Platt, A. M. (Battelle Pacific Northwest Labs., Richland, Wash.); Ramsey, R. W. (Atomic Energy Commission, Washington, D. C.). 1972. 26p. (CONF-721107-3). Dep. NTIS.

From Symposium on the management of radioactive wastes from fuel reprocessing; Paris, France (27 Nov 1972).

Extensive evaluations of permanent or ultimate methods for storage and/or disposal of high-level radioactive wastes are described. Included are use of extraterrestrial transport, trans-

mutation, cavities deep in the earth, the sea bed including use of tectonic subsidence areas, and various combinations of geological and engineered structures. A large number of factors can influence the selection of new methods for the long-term management of radioactive wastes. Because of the sketchy knowledge of these factors at this time, the initial studies have focused on feasibility, timing, and safety. The methodology being used to study these subjects is reported. Specific information is presented on the potential usefulness of transmutation, extraterrestrial disposal, and polar ice for management of nuclear wastes. The requirements of each option for modification in methods of reprocessing or subsequent waste treatment are discussed. (auth)

12595 (ORNL-TM-3781) ENERGY STORAGE IN HIGH LEVEL RADIOACTIVE WASTE AND SIMULATION AND MEASUREMENT OF STORED ENERGY WITH SYNTHETIC WASTES. Jenks, G. H.; Bopp, C. D. (Oak Ridge National Lab., Tenn.). Jan 1973. Contract W-7405-eng-26. 50p. Dep. NTIS.

Experimental and theoretical information on radiation damage and energy storage in oxides and silicates were analyzed, and it was concluded that any energy storage in the calcined oxide-type in the glass-type high-level wastes will result predominantly from displacements or spikes caused by elastic collisions of the heavy recoiling nuclei which are formed in the α disintegration of the transuranic elements within the wastes. Alpha rays and, to a lesser extent, β-rays will also cause some damage through elastic collisions. Energy storage in the radioactive wastes is likely to be less than 200 cal/g, but the possibility that it will be higher in some systems cannot be excluded. Temperatures greater than 1000°C may be needed to effect release of all stored energy with some wastes. The release will not be spontaneous unless there is a step-increase in temperature to a high level at which rapid release is initiated. After burial of the wastes in a salt mine, step increases in temperature are unlikely and, accordingly, spontaneous release of stored energy is unlikely. Step increases in temperature, however, could occur under certain conditions during handling of a can before or after burial. It was also concluded that the radiation damage in radioactive wastes can be simulated in synthetic wastes using fast neutrons or accelerator-ion irradiations (α or H^+). However, use of the latter radiations is unattractive for one or more reasons depending on experiment design. Fast neutrons are the preferred radiations for use in studying energy storage in synthetic wastes. The ORR is recommended for this purpose. Irradiations in this reactor lasting up to about 1 month would provide adequate tests of stored energy in simulated radioactive wastes. A Roux, drop (to high temperature) type calorimeter was designed and constructed for use in planned experimental work with synthetic wastes. The accuracy and the sample size requirements of the calorimeter at the high temperatures (~1000°C) which may be needed with the waste-samples are being investigated in calibration runs. Results to date indicate that the calorimeter will be satisfactory for measurements at 1000 to 1200°C with waste samples weighing about 100 mg. Determination of the stored energy to better than 1 cal/g should be possible, and this accuracy will be adequate with the waste-studies. (P.C.H.)

12596 (SSI-1972-19) SUGGESTED GUIDELINES FOR THE MANAGEMENT OF RADIOACTIVE WASTE IN SWEDEN. (National Inst. of Radiation Protection, Stockholm (Sweden)). Jun 1972. 40p. (In Swedish). Dep. NTIS (U. S. Sales Only).

A report to the National Institute of Radiation Protection is prepared by a working group from the Institute, the Ministry of Agriculture, the Environmental Advisory Committee, the Ministry of Health and Social Affairs, the National Swedish Environmental Protection Board and AB Atomenergi. The production of various types of low- and medium-level wastes has been estimated: Rubbish: 1972, <1000m^3, < 10 Ci; 1980, ~10,000m^3, ~100 Ci; 2000: ~100,000m^3, ~1000 Ci. Medium level: 1972, -, -; 1980, 3000m^3, $3 \cdot 10^5$ Ci; 2000, 40,000m^3, $3 \cdot 10^6$ Ci. Irreversible methods for the disposal of radioactive waste are not accepted which means that burial is not accepted and sea dumping is in principle prohibited by law. Low-level waste is recommended to be stored in drums placed upon a concrete slab and protected from rain by some kind of roofing. Burnable waste is expected to be incinerated. If the waste is not expected to be contaminated with Pu or fission products, ^{60}Co determines the decay time of ~30 years, after which the waste could be disposed. Medium-level waste, dominated by resins, filter aids and concentrates, are either solidified in concrete or bitumen or stored in tanks for decay and subsequent treatment. Wastes from hospitals, universities, and industry will be transported to Studsvik. Waste produced at the reactor sites will probably be stored at or near these sites. (Sweden)

12597 (SSI-1972-29) PANEL TO EXAMINE THE POSSIBILITY OF ESTABLISHING INTERNATIONAL STORAGE SITES FOR HIGH-LEVEL AND ALPHA BEARING RADIOACTIVE WASTES. Hultgren, A.; Snihs, J. O. (National Inst. of Radiation Protection, Stockholm (Sweden)). Oct 1972. 8p. (CONF-721128-1). Dep. NTIS (U. S. Sales Only).

From Panel to examine the possibility of establishing international storage sites for high-level and alpha bearing radioactive wastes; Vienna, Austria (20 Nov 1972).

A forecast of nuclear power in Sweden up to 1990 is given in year/MWe as follows: 1975/3180; 1980/8260; 1985/16,000; and 1990/23,000. The annual waste production based upon a LWR program is expected to produce the following amounts of solidified high-level waste. 1982: 22m^3, 490 MCi; 1987, 42m^3, 980 MCi and 1992 61m^3, 1350 MCi. The annual losses of plutonium to high-level waste and to decladding waste are expected to amount to 1982, 22 kg Pu; 1987, 43 kg Pu and 1992, 61 kg Pu. The following assumptions are also made: cooling time: one year; plutonium losses: 1% to high-level waste 0.1% to cladding waste; waste volumes: solidified high-level waste 0.1m^3/ton U; cladding waste 0.45m^3/ton U. Losses from the fabrication of Pu enriched fuel elements are expected to be in the same order of magnitude as the losses to cladding waste. A Swedish reprocessing plant is not justified before 1990, but the responsibility for the waste produced from fuel of Swedish origin might remain within Sweden. An optimization of the fuel cycle activities: spent fuel transportation, siting of reprocessing plants and of waste repositories, should be evaluated internationally in order to minimize dose commitments. Irreversible methods for the disposal of radioactive high-level waste are not recommended at present. It is recommended that the waste should be solidified and conditioned at the reprocessing plant to meet specifications for transportation and storage. The establishment of international storage sites for high-level and alpha bearing wastes is suggested. (Sweden)

Handling Equipment and Procedures

Refer also to abstract 12396.

12598 (BARC/I-146) GLOVE BOX SYSTEM FOR CARY MODEL 14 SPECTROPHOTOMETER. Natarajan, P. R.; Srinivasan, P. S.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 5p. INIS.

The details of the design of a glove box system, used in conjunction with the Cary 14 spectrophotometer for radioactive work, are reported. The glove box assembly consists of a glove box, transfer box, bellows, insert box and cell holder, of which, the insert box and the cell holder have been fabricated by the Atomic Fuels Division of the Bhabha Atomic Research Center, India. The drawings and photographs of the glove box assembly were supplied by the Oak Ridge National Laboratory, U.S.A. The advantages of this system over the earlier models are reported. The set-up has been used for taking spectra of neptunium and plutonium solutions and some typical spectra are included. (INIS)

12599 (DUN-7807) CRITICALITY SAFETY ANALYSIS REPORT: HANDLING AND STORAGE OF ENRICHED URANIUM TO 1.25 WEIGHT PERCENT IN DUN FACILITIES 313 AND 3712 BUILDINGS. Stickney, R. R. (Douglas United Nuclear, Inc., Richland, Wash.). 3 Jan 1972. 26p. Dep. NTIS.

Based on the criticality safety analysis performed, and other safety analyses of uranium of greater enrichment, the procedures and controls for handling and storing 1.25%-enriched uranium in the 313 and 3712 buildings are reported to be adequate and indicate the capability for safe handling of the material. (TFD)

12600 (LA-3366(Rev.)) CRITICALITY CONTROL IN OPERATIONS WITH FISSILE MATERIAL. Paxton, H. C. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 68p. Dep. NTIS.

This discussion of criticality control is intended to encourage a working knowledge on the part of those who design and perform operations with fissile material. As background, requirements of the Atomic Energy Act are interpreted, and nuclear-safety experience is outlined. Both are shown to be compatible with reasonable principles of nuclear safety. Next, empirical criticality information is presented to help develop a feeling for conditions to be avoided during operations. Criticality-control methods that are consistent with the stated principles and available criticality data are described in the final section. (auth)

12601 APPARATUS FOR OPENING OR CLOSING A FLASK. Vie, R. (to Commissariat a l'Energie Atomique). French Patent 2,109,311. 26 May 1972. Filed 12 Oct 1970. (In French).

An apparatus for the remote closing and opening of a flask provided with a screw lid is presented, the flask being used for cor-

rosive or radioactive products. The apparatus possesses curved parts for gripping the lid. These parts are fixed to a large pitch helical thread and a screw jack having a piston supporting a screw which moves along this thread. In this way, the screw rotates together with the gripping parts and the lid is screwed into or out from the flask. (France)

12602 ARTICULATED SCOOP DEVICE FOR MANIPULATING RADIOACTIVE MATERIALS. Fillias, P.; Mansard, B.; Guillon, L. C. (to Commissariat a l'Energie Atomique). French Patent 2,112,047. 16 Jun 1972. Filed 6 Aug 1970. (In French).

An articulated scoop device for manipulating radioactive products inside hot cells is presented. It consists of a hollow parallelepiped shaped chamber open at one of its ends, a part having two parallel arms separated by a gap just wide enough to accommodate the width of the chamber, a means of articulating the chamber about these arms and a means of fixing the chamber coaxially to the two-armed part. The device is also provided with a mobile biological shielding which includes a housing for the scoop. (France)

Transportation

12603 (DUN-7988) CRITICALITY SAFETY OF URANIUM METAL SCRAP IN MASONRY CONCRETE BILLETS. Toffer, H. (Douglas United Nuclear, Inc., Richland, Wash.). Jun 1972. 32p. Dep. NTIS.

Including uranium as an aggregate in masonry concrete billets is a very simple and inexpensive method for providing: pyrophoric protection; enhanced criticality control; and environmental safeguarding for storing and transporting uranium fines and chips. This technique, as demonstrated, would permit storage and shipment of uranium scarp under considerably increased critical mass limits for all enrichments. The entire criticality study was based on calculations carried out with validated computational techniques. However, it is felt that an extensive use of the uranium concretion process may necessitate experimental critical mass measurements of such materials and configurations. (auth)

12604 (DUN-SA-193) CRITICALITY CONTROL PARAMETERS FOR DISCHARGED FUEL. Miller, R. L.; Toffer, H. (Douglas United Nuclear, Inc., Richland, Wash.). 31 Oct 1972. 22p. (CONF-721109-17). Dep. NTIS.

From International conference on nuclear solutions to world energy problems; Washington, DC (12 Nov 1972).

Based on the use of reliable computational techniques, it has shown that the application of unirradiated fuel element criticality control parameters to irradiated fuel can result in undue conservatism for storing and transporting irradiated fuel elements. Elimination of the conservatism resulting from the establishment of criticality control for irradiated fuel based on unirradiated fuel parameters can result in significant economic gains without compromising criticality safety. (auth)

12605 55/30 AND 85/55 DRUM COMBINATION PACKAGES (19 Jan 1971) (Engineering Materials). (Mound Lab., Miamisburg, Ohio). (CAPE-2312).

4 drawings.

Drawings are presented of the 55/30 and 83/55 drum combination packages for which the Department of Transportation has issued special permit No. 5915. A complete physical and technical description of the packages is presented. The authorized packaging consists of either of two sizes of metal, drum-type "bird cage" packaging, for single trip use only. The Model 55/30 consists of a 55-gal outer drum and a 30-gal inner drum, and the Model 83/55 consists of an 83-gal outer drum and a 55-gal inner drum. For both models, the annular space between the drums is filled with moistened vermiculite. (R.C.K.)

12606 MODEL FSV-2 SHIPPING CASK (15 Mar 1972) (Engineering Materials). (Gulf General Atomic, Inc., San Diego, CA). (CAPE-2310).

17 drawings.

The Model FSV-2 shipping cask is designed to comply with the requirements of 10-CFR-71 and 49-CFR-173 as a Type B package for Type B shipments of mixed fission products. The all-steel cask has an outside diameter of 44 in., and overall height of 67 3/4 in., and a wall thickness of 3 3/4 in. The cask cover is secured to the cask with twelve 3/4-10 UNF-2A alloy steel bolts. A compressed asbestos gasket is used to seal the cask. A steel inner container is placed inside the cask to provide double containment for the contents. The inner container has an inside diameter of 35-1/4 in. and the internal height is 49 in. The inner container cover is bolted to the container flange by twelve 3/4-16 UNF-2A steel bolts. A silicone rubber gasket is used to seal the container. The cask is completely incased by a plywood overpack which has an outside diameter of 70 in. and an overall height of 94 in. The cover of the overpack is secured to the body of the overpack by sixteen 3/4 in. carbon steel bolts. Each bolt extends the full length of the overpack. The total unloaded weight of the overpack, cask and inner container is 16,800 lbs. A detailed description of the cask and its intended use is referenced in "Analysis of a Shipping Cask (Model FSV-2) for Transportation of Mixed Fission Products," Gulf-GA-A10890, April 28, 1972. (auth)

12607 CURIUM SHIPPING CASK (28 Jan 1971) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, SC). (CAPE-2309).

1 drawing.

The SP5738 cask (the curium shipping cask) is used for shipping californium-252 by common carrier. Modifications of the SP5738 cask are described. 1. The top portion of the curium product capsule holddown assembly is removed. 2. A new inner cover plate with an attached dry loading cavity and shielding plug replaces the curium product capsule holddown assembly. 3. The dry cavity (4-in. dia.) is surrounded by 2 in. of lead, cast in concentric stainless steel pipes. 4. The shielding plug for the cavity consists of 22 5/8 in. of polyethylene and 2 in. of lead. This plug is retained by an 8 3/4-in.-dia., 1-in.-thick stainless steel plate bolted to the inner cover plate of the cask. The cask, weighing 7 1/2 tons, is a right-cylindrical, stainless steel, water-filled weldment with external cooling fins. For californium shipments, the cask is overpacked with, and secured inside of, a commercial 20-foot sealed freight container. The cask is limited to a maximum of 40 milligrams of californium-252 in special form as described in DOT Regulation, Section 173.389 (g). The container complies with AEC Manual Chapter 0529 and conforms to the standards for DOT Type B packaging. (auth)

12608 ^{238}Pu OXIDE SHIPPING CASK (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, SC). (CAPE-2308).

7 drawings.

The container is used to ship plutonium-238 (as PuO_2 powder). ^{238}Pu as PuO_2 is loaded into a stainless steel primary container. The primary container is nested within a stainless steel secondary. A stainless steel tertiary container houses the primary and secondary containers and is bolted to a shipping cask cart. A maximum of 350 g of PuO_2 is loaded into the primary container. Any Pu isotopic abundance is permitted except that ^{241}Pu content must be no greater than ^{240}Pu content. The cask is in compliance with AEC Manual Chapter 0529. (auth)

12609 LP-12 TRITIUM CONTAINER (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, SC). (CAPE-2307).

5 drawings.

The LP-12 tritium container is used to ship elemental tritium at low pressure. The tritium is packaged in a 12-liter stainless steel vessel (LP-12), sealed within an aluminum vessel, and surrounded by 3.9-in. thick "Celotex" insulation in a 30-gallon steel drum. Tritium gas may be pure or contain varying amounts of protium, deuterium, or helium. Maximum tritium content is 12,700 cc-STP (32,600 curies). Maximum total pressure in primary container during shipment is 17 psia (880 torrs) at 25°C. The container complies with DOT, Title 49, parts 173-178. The package is not a radiological hazard under normal or hypothetical accident conditions. (auth)

12610 ATMX-500 MODIFICATION OF CRITICALLY SAFE PACKAGE FOR SHIPPING UP TO 200g ^{238}Pu, ^{239}Pu, ^{233}U, AND ^{235}U (6 Jan 1971) (Engineering Materials). (Mound Lab., Miamisburg, Ohio). (CAPE-2311).

4 drawings.

Drawings are presented for the modification of the ATMX Rail Cars for which the Department of Transportation has issued special permit No. 5948. The packaging consists of a specially modified ATMX Series 500 or Series 600 Rail Car loaded with DOT Specification steel drums or wooden crates. A nuclear criticality safety analysis which was initially conducted for DOT-SP-6000 containers is applicable to packaging and shipment of fissile waste material in the ATMX Rail Cars. Design and development considerations regarding the packaging concept and modification of the ATMX-500 Rail Car are presented. (R.C.K.)

PARTICLE ACCELERATORS

Design, Development, and Operation

12611 (AD–743883) NRL VAN DE GRAAFF OPERATION, 1 JANUARY–31 DECEMBER 1971. Dunning, K. L. (Naval Research Lab., Washington, D. C.). Mar 1972. 85p. (NRL-MR–2438). NTIS.

The report is the 7th in a series of summaries on the use of the NRL 5-MV Van de Graaff accelerator and associated instruments. An annual summary for the period 1 January to 31 December 1971 is presented. (auth)

12612 (CONF-720952–3) FORMATION AND ACCELERATION OF RINGS OF ELECTRON–IONS BY A LARGE NUMBER OF PARTICLES. Aleksandrov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). [nd]. 7p. (In French). Dep. NTIS (U. S. Sales Only).

From Symposium on collective methods of acceleration; Dubna, USSR (27 Sep 1972).

The choice of electron–ion ring parameters satisfying the demands of coherent stability and single-particle stability and providing for optimal ion acceleration is discussed. In order to overcome radiative instabilities, there is proposed a narrow chamber protecting the field from the deformations in the ring with those specific frequencies that are multiples of the rotation frequency, ω, but transparent to the slow exterior fields compressing the ring. The variation of the radius of the ring and that of the intensity of the exterior field on the equilibrium orbit are plotted as a function of time for the version of the magnetic system chosen. The layout of the chamber and the magnet windings is shown. (2 figures) (RWR)

12613 (IAE–2122) HIGH-CURRENT ELECTRON ACCELERATOR FOR PHYSICAL RESEARCH. Pevzner, M. I.; Gerasimov, V. F.; Lepnikov, V. F.; Chernoplekov, N. A. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 12p. (In Russian). INIS.

A brief account of the technical characteristics of the accelerator, neutron targets, and auxiliary equipment is presented. The fundamental goal, which is pursued in the presentation of the material, is to provide physicists reference facts for the preparation of experiments performed at the accelerator. (tr-auth)

12614 (LA-DC–72–1253) Δt TURN-ON PROCEDURE. Crandall, K.; Jameson, R. A.; Morris, D.; Swenson, D. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-721046–22). Dep. NTIS.

From Proton linear accelerator conference, Los Alamos, NM (10 Oct 1972).

The Δt procedure is used for determining the rf phase and amplitude set points in modules 5 through 12 of LAMPF. The theoretical background as well as the experimental results are described. (auth)

12615 (LA-DC–72–1391) STATUS OF LAMPF. Rosen, L. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 8p. (CONF-721124–1). Dep. NTIS.

From sixth LAMPF users group meeting; Los Alamos, NM (13 Nov 1972).

Topics include construction budgets, unfinished construction, new construction, management, operating budgets, and approved proposals. (W.H.K.)

12616 (LBL–986) NEUTRON DOSIMETRY AT HIGH ENERGY PARTICLE ACCELERATORS: A REVIEW. Thomas, R. H. (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1972. Contract W-7405-eng-48. 36p. (CONF-721203–7). Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Lessons learned in the development of techniques of measurement in mixed radiation fields for accelerators and the interpretation of these measurements are discussed. A historical background for the years 1945–66 is given first. By the middle of 1966 there were conflicting data on the shapes of the equilibrium neutron spectrum above a few MeV. During the years 1966–72 the apparent anomalies in the spectra derived from emulsion data and the dose-equivalent composition data from different laboratories were resolved. This was brought about primarily by the application of threshold detectors to the measurement of radiation fields, the determination of neutron spectra from these threshold detector measurements, increases in operational experience at several accelerators around the world, a better understanding of particle spectra to dose-equivalent conversion, and theoretical studies of the nuclear cascades generated by high-energy particles. (11 figures, 5 tables, 70 references) (R.W.R.)

12617 (LBL–1070) LONGITUDINAL COUPLING IMPEDANCE OF A STATIONARY ELECTRON RING IN A CYLINDRICAL GEOMETRY. Faltens, Andris; Laslett, L. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 20p. (CONF-720952–2). Dep. NTIS.

From Symposium on collective methods of acceleration; Dubna, USSR (27 Sep 1972).

The longitudinal (azimuthal) coupling impedance is investigated for a stationary electron-ring beam circulating between a coaxial pair of conducting tubes. Proximity of the beam to the inner tube is found to be advantageous for reducing $(|Z_n|/n)_{max}$. Similar results are shown to be attainable with operation near the outer tube, provided the quality factors, Q, for higher-order resonant modes are deliberately made small. Illustrative computational results are presented graphically, and a convenient approximate formula is suggested that may serve to guide the selection of desirable parameters for a typical fully compressed electron ring. (7 figures) (auth)

12618 PULSED BEAM METHOD AT HIGH CURRENT ACCELERATORS. Czapek, G. (Univ., Bern); Hahn, B.; Markees, A.; Schacher, J.; Schryber, U. Nucl. Instrum. Methods; 105: No. 3, 609-11(1972).

For the study of delayed processes at high-current accelerators a pulsed beam operation mode is proposed. Fast background can be reduced considerably, depending on the beam suppression factor. (1 figure) (auth)

12619 ION-CLUSTER ACCELERATION IN AN ELECTRON-RING DEVICE. Bottiglioni, F. (EURATOM-CEA, Fontenay-aux-Roses, France); Coutant, J.; Fois, M.; Cuer, M. Nucl. Instrum. Methods; 106: No. 1, 127-33(1973).

Problems dealing with ion-cluster acceleration by relativistic electron rings are examined. Particular shapes of magnetic fields as well as minimum lengths of accelerating stage, required by cluster inertia, are shown in dependence on the final energy of clusters, on their size, and on the total amount of accelerated matter. The energy efficiency of such accelerators can, therefore, be exactly deduced. Effects on the cluster stability of the very high existing electric fields, collisions with ring electrons, and collisions with gas molecules are examined. On the basis of existing data, it is concluded that clusters should not be broken up or vaporized; therefore, ion-cluster acceleration by electron rings appears feasible. (4 figures, 1 table) (auth)

12620 KAZAKHSTAN VARIABLE ENERGY ISOCHRONOUS CYCLOTRON. Arzumanov, A. A.; Nemenov, L. M. (Inst. for Nuclear Physics, Alma-Ata, USSR). Nucl. Instrum. Methods; 106: No. 1, 201-2(1973).

The results of conversion of the cyclotron of the Institute for Nuclear Physics in Alma-Ata to a variable-energy isochronous cyclotron are reported. (auth)

12621 ACCELERATORS FOR NUCLEAR PHYSICS. Clark, D. J. (Univ. of California, Berkeley). Rep. Progr. Phys.; 35: No. 9, 1007-75(1972).

The principal charged particle accelerators being used today for research in nuclear physics in the energy range up to about 1000 MeV are described. The accelerators include Van de Graaffs, sector cyclotrons and linear accelerators for both positive ions and electrons. For each type of accelerator a brief treatment is given of the recent history, operating principles, some special techniques, a typical facility, and some examples of experimental data from that type of accelerator. Descriptions are also given of new types of machines under construction, such as pelletrons, frequency modulated sector cyclotrons, separated sector cyclotrons and superconducting linear accelerators. New ideas for the future are mentioned, including multistage tandem cyclotrons and the electron ring accelerator. (auth)

12622 POSSIBLE DESIGNS AND APPLICATIONS OF EXPLOSIVE ULTRAHIGH MAGNETIC FIELD ACCELERATORS. Panasyuk, V. S.; Sokolov, A. A.; Stepanov, B. M. At. Energ. (USSR); 33: No. 5, 907-12(Nov 1972). (In Russian).

Several designs of single-shot accelerators having ultrahigh magnetic fields generated by magnetocumulative generators are presented. Betatron and high-frequency cyclic accelerators, as well as direct-action accelerators, are considered. Various methods of particle injection and extraction are described. Possible applications of the cyclic accelerators described are as-

sessed for obtaining superhigh-energy particles. Such accelerators seem promising for the acceleration of beams of secondary particles, as well as for experiments on μ-meson and π-meson intersecting beams, which are of fundamental importance for high-energy physics. (5 figures, 10 references) (auth)

12623 MICROSECOND DURATION INTENSE RELATIVISTIC ELECTRON BEAMS. Friedman, M.; Ury, M. (Naval Research Lab., Washington, D. C.). Rev. Sci. Instrum.: 43: No. 11, 1659-61(Nov 1972).

A preliminary study was performed to ascertain the feasibility of delivering large quantities of electrical energy in relativistic electron beams of long pulse duration. An electron beam of 8 kA peak current and 250 kV peak voltage was produced with a duration of $\gtrsim$1 μsec. The electron beam was transported through a 1 m long drift tube with little energy loss. (auth)

12624 COMPACT LOW COST COLLECTIVE EFFECT LINAC. Heese, Norbert R.; Raudorf, W. R. (Sir George Williams Univ., Montreal). Rev. Sci. Instrum.: 43: No. 11, 1594-1600(Nov 1972).

An inexpensive linear accelerator for electrons was built and is now in operation. The acceleration is accomplished by an electrodynamical space-charge effect in a cylindrical electron beam. The 2.5 m long instrument, operated with a 20 keV, 350 mA beam, produces electrons of energies up to 14 MeV. Design and operational characteristics are presented along with the results of performance tests. (auth)

12625 HEAVY ION BEAMS IN BIOLOGY, MEDICINE, AND CHEMISTRY. Keller, C. (Kernforschungszentrum, Karlsruhe, Ger.). Naturwiss. Rundsch.; 25: No. 8, 308-309(1972). (In German).

The main activities of the research centers concerned with heavy ions, such as the Lawrence Radiation Laboratory, the BEVATRON which yields 36 GeV N14 ions, and the HILAC, presently in the process of construction, are summarized. Two cyclotrons are available in Dubna/USSR, and the ALICE linear accelerator in Orsay can also be used to accelerate heavy ions. One of the main activities in the field of heavy ions research is the production of superheavy nuclei. Another field of application in biology and medicine is cancer research and therapy. (INIS)

Auxiliaries and Components

Refer also to abstract 12677.

12626 (CERN-Trans-72-13) SYSTEM FOR FAST BEAM SPILL ONTO THE INTERNAL TARGET OF THE IHEP ACCELERATOR. Gridasov, V. I.; Danil'chenko, I. A.; Zelenov, B. A.; Kuznetsov, E. P.; Kurnaev, O. V.; Merker, E. A.; Myznikov, K. P.; Ryabov, Yu. G.; Tarakanov, N. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by B. Hodge (CERN, Geneva), from report IFBE-SKU-70-84. 13p. Dep. NTIS (U. S. Sales Only).

The system uses a slow C-shaped iron magnet having a magnetic field rise time of about 0.5 ms and a feedback system for directing the accelerated beam away from the target after a given number of particles have passed through the bubble chamber. A block diagram of the system is given and characteristics are discussed. (W.H.K.)

12627 (LA-DC-72-1288) CAVITY TUNING FOR THE LAMPF 805 MHz LINAC. Swain, G. R.; Jameson, R. A.; Kandarian, R.; Liska, D. J.; Martin, E. R.; Potter, J. M. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 9p. (CONF-721046-18). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

As the construction of the LAMPF 805-MHz side-coupled linac progressed, tools and techniques were developed for tuning the rf cavities making up the structure. Ten thousand cavities were adjusted to precise frequency settings in a manner that limited field deviations to ±6% from the average. Pre- and post-assembly tuning procedures are described, including the nose-stretching and dinging techniques. A method for correcting field unflatness using a combination of septum bending and the techniques above is given. Selected results are compared with the theory of the effects of frequency and coupling constant errors on the structure field distribution. Refinements to the computerized beadpull measurement system for rapid determination of field flatness are presented. (auth)

12628 (LA-DC-72-1301) COMPUTER CONTROL OF LAMPF's 201.25 MHz RF. DeHaven, R. A. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 7p. (CONF-721046-14). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

LAMPF's 201.25-MHz power systems consist of four individual stands, three of which are identical, each utilizing a three-megawatt final amplifier stage. The fourth stand consists of two 250-kilowatt amplifiers operating in parallel. The turn-on sequencing and fault protection of each of the amplifiers is built into the hardware associated with the stand. A general discussion of the scope, organization, and operator interface of a Fortran software system that has been devised to automate the control of the 201.25-MHz stands is presented. The programs contain the following general features. Upon operator command, the system will turn on any combination of the four amplifiers in a parallel manner from a cold start, monitor their operation on a continuous basis, and attempt to recover from a fault-initiated shutdown. If a computer recovery is impossible, the system attempts to diagnose the problem and inform the operator of the cause. At the operator's discretion, the system will shut the stands completely down or merely turn the high voltage off, the latter procedure keeping the amplifiers in a standby mode. The system logs the resets issued to the equipment and the messages written for the operators during the turn on and monitoring phase. The software system consists of twelve Fortran programs with a total of some 15,000 words, one executive program, and two data files constructed to run in LAMPF's SEL 840 MP control computer. (auth)

12629 (LA-DC-72-1310) CONSTRUCTION OF ALUMINA INSULATED BENDING MAGNETS FOR LAMPF. Bush, E. D, Jr.; Rhorer, R. L. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 9p. (CONF-721046-13). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

The fabrication techniques and operating characteristics of three small bending magnets utilized in the LAMPF accelerator are presented. All three magnets are necessarily small as dictated by various boundary conditions; however, each utilizes a different design philosophy to satisfy its particular requirements. One is required to withstand a 1500°F H_2 furnace brazing temperature, another is required to fit within a half drift tube. The last consists of two bending magnets in a common iron core assembly, with a very high conductor current density and severe space limitations. The operating parameters are tabulated. All magnets described herein are virtually radiation hard. (auth)

12630 (LBL-1311) COMPUTER-CONTROLLED, 3-D MAGNETIC FIELD MAPPING SYSTEM. Dols, C. G. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 10p. (CONF-720908-25). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

From January 1963 until July 1970 the Magnetic Measurements Group at LBL surveyed the magnetic fields of 104 magnets with a measuring system controlled by a special-purpose digital computer. In July of 1970 the special-purpose computer was replaced by a Digital Equipment Corporation PDP-5. The modified system has demonstrated flexibility, convenience, and reliability during the execution of 13 varied magnet field measuring programs. Since March 1972 the system has been measuring three orthogonal components of magnetic field at each grid intersection in each pass. This paper discusses some of the advantages of the general-purpose computer and describes recent developments of the system. (7 figures, 1 table) (auth)

12631 (LBL-1329) SUPER-HILAC VACUUM SYSTEM. Mirk, K. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1972. Contract W-7405-eng-48. 13p. (CONF-721046-24). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

The Super-Hilac Accelerator has two large rf cavities with a combined volume and surface area of 13,000 ft^3 and 9,200 ft^2. The system whereby these cavities are vacuum pumped cryogenically to operating base pressures in the low 10^{-7} torr range is described. (auth)

12632 (SC-DR-720851) HIGH ACCURACY CALIBRATION TECHNIQUES FOR INTENSE RELATIVISTIC ELECTRON BEAM MONITORS. Bolduc, P. E.; Phillips, A. R.; Vandevender, W. H. (Sandia Labs., Albuquerque, N. Mex.). Nov 1972. 81p. Dep. NTIS.

Rogowski coils, B_θ coils, resistive shunts, and Faraday cups are used extensively to monitor fast pulsed currents in controlled fusion and relativistic electron beam experiments and in other experiments where an accurate time history of the current pulse is needed. Since each of these monitors has a characteristic response time determined by its self-inductance, capacitance, and resistance, it is important that each be calibrated against a stan-

dard unit under conditions that are at least as stringent as those encountered in an actual experiment. An analytical procedure consisting of a linear least squares fitting routine derived from a linear regression analysis is developed which yields the best estimate of the test monitor's calibration factor and also its fidelity of pulse reproduction. The method can also be used to obtain the operational tube inductance of a pulsed relativistic electron beam accelerator and the time correlation between the voltage and current monitors of such a tube. Finally the procedure also permits a straightforward calibration of RC integration networks. (auth)

12633 RADIATION AREA MONITORING SYSTEM AT NAL. Shafer, R. (National Accelerator Lab., Batavia, IL). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 457-9(Jun 1972).

A digital multiplexing system for monitoring radiation levels adjacent to approximately eight (8) miles of beam line with over 500 detectors is being implanted at NAL. Data from individual detectors is collected in a central area via a dedicated-time-slot digital multiplexing system, designed for high reliability rather than high bit rates, and is completely independent of any accelerator control system. Data processing is performed in a hardwired core memory system, and record keeping is accomplished via a link to the Accelerator Control Computer. A wide variety of oscilloscope displays are available for selective intensification of data. (3 figures) (auth)

12634 TRIP-OUT CIRCUIT FOR ARCING OR FREE-RUNNING TRIGGER PULSES IN A LINEAR ACCELERATOR. Bottrill, D. O.; Jamal, M. A.; Ahmed, K. I. (Inst. of Radiology and Nuclear medicine, Baghdad, Iraq). Phys. Med. Biol.; 17: No. 6, 849-50(Nov 1972).

A discrete-component transistorized circuit is described, which can monitor the high voltage pulse forming network (PFM) of a linear accelerator using the voltage developed over a 10 Ω resistor placed in series with the high voltage power supply capacitor. In normal operation, the output of the circuit is used to close the contacts of a relay in series with the high voltage power supply trip circuit. The relay is de-energized, and hence the high voltage power interrupted whenever arcing occurs in the PFN. The relay will also de-energize if the pulse repetition rate rises above some variable but present level, e.g., 450 Hz when normal operation is at 250 Hz. Hence the high voltage power is interrupted if the free running should occur in the trigger pulse generator for the main thyratron. (UK)

12635 METHOD FOR OBTAINING PROGRAMMED BEAM SINGLE SHOTS AND PULSE TRAINS FROM A DIODE GUN LINEAR ELECTRON ACCELERATOR. Martin, Diana; Nemes, Mirela (Inst. of Atomic Physics, Bucharest). Nucl. Instrum. Methods; 105: No. 3, 605-8(1972).

A method for obtaining programmed beam single shots and pulse trains from a diode gun electron linac by discrete pulse position modulation of gun and/or magnetron pulses is presented. (3 figures) (auth)

12636 ASTRON ON-LINE BEAM ENERGY ANALYZER (28 Nov 1972) (Engineering Materials). (California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2306). 48 drawings.

12637 BEAM CURRENT AND POSITION MONITOR FOR THE ASTRON ACCELERATOR. Fessenden, T. J.; Stallard, B. W.; Berg, G. G. (Univ. of California, Livermore). Rev. Sci. Instrum.; 43: No. 12, 1789-92(Dec 1972).

A beam current and position monitoring system very similar to one developed for the Berkeley ERA accelerator has been developed for use in the Astron accelerator. Beam current measurements are accurate to less than 2%. At beam currents above 500 A, beam displacements of less than 1 mm off-axis can be observed. The beam current and position at any two of 30 locations in the accelerator and transport section can be simultaneously monitored on either of two oscillograph systems. The current sensors do not interfere with the beam propagation and are outside the vacuum system for easy maintenance and calibration. (auth)

12638 NONTUNING ACCELERATOR WAVEGUIDE WITH VARIABLE DRIVING FREQUENCY. Volodin, V. A.; Shal'nov, A. V. (Moscow Engineering Physics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 982-7(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1235-41(Jun 1972).

The properties of a nontuning accelerator waveguide with variable driving frequency are investigated, taking account of the influence of the current load of the accelerated beam. Both uniform and nonuniform accelerator waveguides are considered. The possibility of optimization and the properties of the optimum waveguides are studied. It is shown that the main characteristics of the equivalent accelerating gap vary symmetrically with respect to the sign of the frequency deviation; this fact affords the theoretical possibility of almost complete transformation of the high-frequency lower input into beam power, even for a nonzero synchronous phase. (auth)

12639 SEGMENTED FARADAY CUP TO MEASURE kA/cm^2 ELECTRON BEAM DISTRIBUTIONS. Pellinen, Donald (Physics International Co., San Leandro, Calif.). Rev. Sci. Instrum.; 43: No. 11, 1654-8(Nov 1972).

A segmented Faraday cup using 3.5 mm diam collectors has been used to measure electron beam current densities with incident power fluxes as high as 30 GW/cm^2. The detector system has a rise time of 1 to 2 nsec. (auth)

12640 PARAMETERS FOR THE CONDUCTING WALL OF A LINEAR INDUCTION ACCELERATOR. Vakhrushin, Yu. P.; Gagen-Torn, V. K. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1152-5(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1446-51(Jul 1972).

The requirements that must be satisfied by the conducting wall of the accelerator tube of a linear induction accelerator are discussed. Expressions are derived for the wall conductivity and the tolerable inhomogeneities. The minimum value of the conductivity is determined from the allowable potential across the tube and the allowable difference in the fields at the ends. The maximum value of the conductivity is limited, for economic reasons, by the allowable current that flows through the walls. It is concluded that in principle it is possible to use a tube with a conducting wall in a linear induction accelerator. (auth)

12641 TWO-STAGE DEVELOPMENT OF A DISCHARGE IN A MEDIUM CONTAINING SPACE CHARGE. Voiko, V. A.; Kushin, V. V.; Uksusov, N. I.; Shmygov, A. M. (Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1196-8(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1500-3(Jul 1972).

A study is made of processes responsible for damage in various dielectric units mounted on charged-particle accelerators. The damage is shown to be caused by electrical breakdown of the dielectric as a result of the space charge built up by randomly impinging accelerated electrons. It is concluded that discharges in space-charged dielectrics develop in two stages, which differ in the electric field configuration near the breakdown channel. The second stage of the discharge is responsible for the destructive effect and propagates to large distances, even for comparatively small space-charge potentials. (auth)

Ion Sources and Injection and Extraction Systems

Refer also to abstract 13697.

12642 (ANU-P-558) A.N.U. CYCLOTRON INJECTOR. Ophel, T. R. (comp.) (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 42p. Dep. NTIS (U. S. Sales Only).

A brief description is given of the essential features of the CNI-30 cyclotron which has been installed to inject negative ion beams of 26 MeV protons or 14 MeV deuterons into the tandem. Various aspects of cyclotron operation are presented along with a summary of the acceptance measurements and a simplified operating guide. (auth)

12643 (BNL-17293) ION SOURCES FOR PROTON LINACS. Sluyters, Th. (Brookhaven National Lab., Upton, N. Y.). 17 Oct 1972. 21p. (CONF-721046-19). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

(I) The performance of the ion sources in the proton linear accelerators at the following laboratories is reviewed: National Accelerator Laboratory (U.S.A.), Argonne National Laboratory, Rutherford High Energy Laboratory, CERN, Los Alamos Scientific Laboratory, Centre d'Etudes Nucleaire (Saclay), Institute for High Energy Physics (Serpukhov), Brookhaven National Laboratory, and Institute of High Energy Physics (Tsukuba, Japan). The ion source for these accelerators is the duoplasmatron with plasma expansion cup. Parameters for the various sources are tabulated. Plasma expansion from duoplasmatrons to obtain ion currents up to 100 mA and ion densities up to 60 mA/cm^2 are reported. These expansion cups are not larger than 1.5 cm in dia, and insulated walls provide some control on the density distribution. For higher intensities and larger expansion cups, the transport of plasma is more complex: insulated walls do not have a significant effect. Miniature shielded solenoids located close to the anode aperture appear to be effective for high-density plasma transport. Optimum

beam-optical results are often obtained when extraction takes place close to the space charge-limited current. The development of a PIG source as a high-intensity proton source is a promising possibility to increase the brightness by another order of magnitude, a feat difficult to achieve with present plasma expansion techniques from duoplasmatrons. (II) Reasons for developing intense sources of H^- beams are discussed. If reliable and reasonable beams can be obtained after the linac, replacing multiturn injection with nontransparent septums by stripping of H^- to H^+ with a thin transparent target located on the closed orbit may result in 10^{13} to 10^{14} particles per pulse. Several different sources and extraction systems are described for injection of H^- beams. (18 figures, 2 tables) (R.W.R.)

12644 (CEA-CONF-2097) E.C.R. ION SOURCE FOR STRIPPED NITROGEN. Apard, P.; Bliman, S.; Geller, R.; Jacquot, B.; Jacquot, C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 6p. (CONF-720948-12). Dep. NTIS (U. S. Sales Only).

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

Totally stripped nitrogen ions are obtained in the experiment called MAFIA 7^+ (abbreviation for Mesure d'Abondance d'un Faisceau d'Ions d'Azote 7^+) based on electron cyclotron resonance in a magnetic mirror configuration. Auger cascades and shake off collisions seem to be the main ionization phenomena. (auth)

12645 (LA-DC-72-1267) OPERATION AND PERFORMANCE OF THE HIGH-INTENSITY PROTON INJECTOR OF LAMPF. Mueller, D. W.; Meyer, E. A.; Stevens, R. R. Jr.; Goplen, B. C.; Paciotti, M. A.; Emigh, C. R. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 9p. (CONF-721046-23). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

The recent operational experience with the LAMPF high-intensity proton injector is presented. Extensive beam measurements have been carried out on the ion beam extracted from the accelerating column and the results are compared with the behavior expected from a Pierce column. Improvements made in the ion source and other injector systems are presented; operation over a wider range of extracted currents without arc down is now possible. A major cause of arc down in the accelerating column was traced to occasional failure of the arc modulator turn-off circuit and has been eliminated. A procedure for enhancing the hydrogen pumping speed of the ion pumps is discussed. (auth)

12646 (LA-DC-72-1309) BEAM TRANSPORT STUDIES ON THE PROTON BEAM LINE IN THE INJECTOR COMPLEX OF LAMPF. Stevens, R. R. Jr.; Goplen, B.; Stovall, J. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 8p. (CONF-721046-16). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

As a result of beam measurements made at the exit of the accelerating column in the high-intensity proton injector, additional quadrupole lenses have been incorporated in the proton beam transport line. The design for the new transport system and the beam measurements subsequently carried out with this new design are presented and the improvement in operation is discussed. Electron neutralization effects have been observed and must be accounted for in the design and operation of this beam line. (auth)

12647 (LBL-912) BEAM EXTRACTION FOCUSING COILS FOR THE BEVATRON. Hoyer, Egon (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 10p. (CONF-720908-28). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

A nested quadrupole and sextupole coil system to enhance proton beam extraction from the Bevatron is discussed. The integrated quadrupole field, nominally 50 kG/in., is obtained with four current sheets, approximated with 32 conductors. Internal to the quadrupole coil, a six-conductor coil produces the sextupole field. A clear beam aperture of 3.5 in. by 3.0 in. is provided with good field in the 2.5 in. by 1.5 in. central region. The coil system, housed in a stainless steel support structure, is located in the gap of the main guide field magnet and in the Bevatron's main vacuum system just upstream of the accelerator beam exit port. Remote positioning of the coil system is accomplished with motor driven screw drives for different extraction beam orbits. Focusing coils and positioning equipment were installed in June, 1972, and have operated successfully during tests. (auth)

12648 HIGH TEMPERATURE ION SOURCE FOR ISOTOPE SEPARATORS. Johnson, P. G.; Bolson, A.; Henderson, C. M. (Univ. of California, Livermore). Nucl. Instrum. Methods; 106: No. 1, 83-7(1973).

A surface-ionization ion source which operates by heating a capped tungsten crucible to 2800 to 3300°C by electron bombardment is described. A steep temperature gradient along the length of the cylindrical crucible allows it to be used both as a furnace for evaporation and as a hot surface for dissociation and ionization of the sample. Yields of up to 73% are claimed for milligram quantities of lanthanides and actinides. (5 figures, 1 table) (auth)

12649 NEGATIVE HELIUM ION SOURCE WITH POTASSIUM VAPOUR CHARGE EXCHANGE. Vermeer, A.; van Zwol, N. A.; Strasters, B. A. (State Univ., Utrecht). Nucl. Instrum. Methods; 106: No. 1, 115-20(1973).

A negative helium ion source is described which uses potassium as an exchange vapor. Beam currents of >3 μA are obtained at an extraction voltage of about 12 kV. The ion source could also be used for the production of negative ions of the elements S, O, Cl, and C. (6 figures, 1 table) (auth)

12650 INFLUENCE OF THE MOMENT OF INJECTION OF PARTICLES INTO THE CHAMBER ON THE CAPTURE OF ELECTRONS IN THE BETATRON REGIME OF ACCELERATION. Tulinova, N. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 158-61(1972). (In Russian).

In previous work on the duration of particle injection on electron capture during betatron acceleration, the duration of injection pulse has been equated to the "capture domain", where the "capture domain" is that interval of time in which the radius of the momentary orbit changes from the radius of injection to the radius of an equilibrium orbit. It is shown experimentally that the capture of electrons occurs practically within the entire "capture domain"; the duration of injection corresponded to a few hundredths of a part of the "capture domain." (KSW)

12651 LOW-FREQUENCY OSCILLATIONS IN PENNING-DISCHARGE PLASMA UNDER CONDITIONS OF CYCLOTRON ION SOURCE. Romanyuk, L. I.; Slobodyan, V. M. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 818-24(May 1972). (In Russian).

Conditions were experimentally studied for onset of low-frequency oscillations and their fundamental characteristics in the oscillating electron–ion source, used in cyclotrons. These oscillations are shown to be a consequence of the discharge instability. The oscillations in the ion source are established to cause considerable modulation of the ion beam extracted from the source and accelerated in the cyclotron. (auth)

12652 PRESENT STATUS OF THE PHYSICS AND ENGINEERING INVOLVED IN THE GENERATION OF POLARIZED PARTICLE BEAMS. Plis, Yu. A.; Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Usp. Fiz. Nauk; 107: No. 1, 281-319 (Jun 1972). (In Russian).

The atomic beam technique is described, reviewing the dissociation of the hydrogen molecule and the behavior of H and D atoms in a magnetic field, the magnetic separator, radiofrequency transitions in weak and strong fields, the formation of negative ions, the charge exchange of positive polarized ions and ionization by heavy particles. Lambs method, involving the formation of ion beams based on hydrogen excited at the metastable $2S_{\frac{1}{2}}$ is also discussed in detail. Finally, methods used for measuring the polarization of fast and slow ions, polarized ^{3}He and Li sources, the injection of ions into accelerators and their acceleration are described. The field is developing very rapidly; H and D beams of 5 μA have been achieved. Use of quantum transitions allows to vary the vector and tensor polarization of the polarized ions within a broad range. (review article, 149 references) (TTT)

12653 ELECTRON CAPTURE EFFICIENCY IN A BETATRON REGIME OF ACCELERATION AT VARIOUS REGIONS OF PULSE INJECTION. Tulinova, N. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 4, 469-71(1972). (In Russian).

Electron capture during a betatron regime of acceleration was studied to determine the role of different ranges of impulse injection. A change in the duration of the front altered the effective length of the pulse which determined both the form of the pulse delivered to the injector and the momentum of the injection. The intensity of the γ-radiation was studied as a function of the effective duration of the pulse. (KSW)

12654 SOURCE OF POLARISED ELECTRONS. Campbell, D. M.; Brash, H. M.; Farago, P. S. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 165-80(1972).

A prototype source of polarized electrons is described, in which electrons trapped by a combination of electric and magnetic fields are polarized through spin exchange interaction with a polarized beam of potassium atoms. Under typical operating conditions, a pulsed electron beam was extracted with 10^4 electrons per pulse and a polarization of 0.45 at a repetition rate of 50 s^{-1}. The scope for improvement of these figures is briefly discussed. Values for the total spin exchange collision cross-section at elec-

tron energies of 1 eV, 2.5 eV and 4 eV were obtained. These are in reasonable agreement with theoretical predictions. (auth)

12655 INVESTIGATION OF ELECTRON MOTION IN EXTRACTION FROM AN ELECTRON SYNCHROTRON USING THE NONLINEAR RESONANCE OF BETATRON OSCILLATIONS $\nu_r = 2/3$. Vizir, V. A.; Rakhmatulina, Z. N.; Chuchalin, I. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 81-5(1972). (In Russian).

In the study of accelerated particles from a cyclic accelerator a method of excitation of resonances of betatron oscillations was used. It was convenient to employ the nonlinear resonance or radial betatron oscillations $\nu_r = 2/3$. The trajectory of the beam was calculated making allowance for energy losses and frequency shifts of the betatron oscillations. The dependence of the frequency of the latter on the number of revolutions was investigated at various energies. (KSW)

Ion Optics and Field Calculations

12656 (CERN-Trans-72-14) APPLICATION OF NON-LINEAR RESONANCES OF BETATRON OSCILLATIONS IN SLOW PARTICLE EJECTION FROM ACCELERATORS WITH STRONG FOCUSING. Fedotov, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov, Institut Fiziki Vysokikh Energii). Translated by B. Hodge (CERN, Geneva), from report IFVE-SKU-71-63. 25p. Dep. NTIS (U. S. Sales Only).

An examination of the processes that take place in the presence of nonlinear betatron oscillation resonances shows that there are great possibilities for using them for slow extraction. The reason is that these resonances break down the phase plane into regions that have different qualities of motion. The choice of the type of resonance and form of perturbation depends on the nature of the accelerator, the requirements placed on the extracted beam, and the technical possibilities of creating a nonlinear perturbation. The general requirements for the extracted beam are a low emittance and uniform intensity during extraction. The latter requirement is more easily satisfied if the resonance band is sufficiently wide. The most suitable resonances are the third-order resonance for quadratic nonlinearity and the second-order resonance when there is the combined action of the cubic nonlinearity and gradient. The first-order resonance is particularly unsuitable. (4 figures, 1 table) (RWR)

12657 (JINR-P9-6733) CLOSED ORBIT ELONGATION EFFECT IN PERIODICAL MAGNETIC FIELDS. Dmitrievskii, V. P.; Kol'ga, V. V.; Polumordvinova, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effect of closed orbit elongation in periodical magnetic fields is considered. The conditions are found for essential elongation of closed orbits by emittance conservation. (1 figure) (auth)

12658 (JINR-P9-6755) COMPUTATION OF THREE-DIMENSIONAL ELECTROSTATIC FIELDS BY THE GRID METHOD. Vorozhtsov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is proposed to use the Shwartz's method for computations of three-dimensional electrostatic fields. The grid method is used for computations in separate regions of solution. The advantages of the method are shown and examples of computations in comparison with experimental data are given. (auth)

12659 (JINR-P11-6561) CALCULATION OF ELECTROMAGNETIC FIELDS IN DOUBLE-COUPLED RESONATORS BY THE NET-POINT METHOD USING DISPLAY. Derendyaev, Yu. S.; Karlov, A. A.; Rubin, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Electromagnetic fields in the double-coupled resonator are calculated by the net-point method. On the display screen one gets the distributions of the components of the electrical field and potential. The obtained results are used in calculating the quality of the half-wave band resonator at a given intrinsic frequency and the surface resistance of a band and resonator wall. (auth)

12660 (LA-DC-72-1289) AUTOMATED ADMITTANCE MEASUREMENT AT LAMPF. Stovall, J. E. (Los Alamos Scientific Lab., N. Mex.). 1971. Contract W-7405-eng-36. 6p. (CONF-721046-17). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

A computer code was written to automate admittance measurements in the drift tube portion of LAMPF. The procedure was used to identify a misalignment in the first linac tank. The experimental procedure is discussed, and the results are compared with those generated numerically. (auth)

12661 (LBL-906) ASSESSING AND CONTROLLING EDDY-CURRENTS IN CONDUCTORS OF FAST-PULSED COILS. Avery, R. T.; Laslett, L. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 7p. (CONF-720908-24). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

Measurement and analysis of the pulsed magnetic field of an early Berkeley ERA electron-ring accelerator apparatus indicated significant undesirable perturbations due to induced eddy currents in the copper magnet conductors. Mathematical models were constructed which gave close estimates of the eddy currents and their associated magnetic field perturbations. Based on this analysis, the size and material of the conductors of a later ERA apparatus were selected to give suitably low field perturbations due to eddy currents. This has been confirmed by magnetic measurements. (auth)

12662 (SLAC-Trans-148) STUDY OF THE STOCHASTIC INSTABILITY OF THE BETATRON OSCILLATIONS OF AN ELECTRON BEAM IN A STORAGE RING. Kulipanov, G. N.; Mishnev, S. I.; Skrinskii, A. N. Translation of a Russian Preprint. 51p. Dep. NTIS.

An experimental study of the behavior of the beam in an electron storage ring under the combined influence of two betatron-oscillation resonances and on periodic passage through a resonance is presented. Conditions resulting in different types of particle motion are studied. Observations made, depending on the experimental conditions, include: a) the existence of independent stable regions of phase stability; b) the appearance of second-order phase-stability regions and the formation of a stochastic layer near the boundary of the phase-stability region; and c) a complete destruction of the phase-stability regions which imparts a stochastic character to the variation of the betatron-oscillation amplitudes. The experimentally found conditions under which stochastic instability develops are compared with the theoretical findings of B. V. Chirikov. Experiments are described that prove the diffusional character of the particle motion in the stochastic region, as well as other experiments elucidating the character of the diffusion. (auth)

12663 OPTIMUM TRANSPORT IN CHARGED PARTICLE ANALYSERS. Wang, K. L. (Massachusetts Inst. of Tech., Cambridge). J. Phys., E (London); 5: No. 12, 1193-6(Dec 1972).

The optimum transport of charged particle beams in a device with some required constraints may be achieved by using the Lagrange multiplier technique. Applications to energy analyzers and mass spectrometers are given to show that the maximum transport can be obtained by making a compromise between the semi-angular aperture and the resolution slit width. An analyzer having a higher order of residual spherical aberration gives larger transport at high resolution and thus is a more sensitive device. Matching the emittance of a source to the acceptance of a device is necessary for the entire optical path. (auth)

12664 POTENTIAL OF A QUADRUPOLE LENS. Derevyankin, G. E. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 937-9(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1178-81(Jun 1972).

An exact solution is presented for the potential of a quadrupole lens given the gradient on the axis. In the general case the potential is expressed in the form of an integral. (auth)

12665 MOTION OF A CHARGED PARTICLE IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Glikman, L. G. (Inst. of Nuclear Physics, Alam-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 940-3(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1182-5(Jun 1972).

Motion of a charged particle in a constant axially symmetric magnetic field is investigated, with the simplifying assumptions that the particle moves near the axis of symmetry z and that the vector potential of the field is $A = (r/2)H(z)$, where $H(z)$ is the magnetic field on the axis and r is the distance of the particle from the axis. Estimates are made of the orbital magnetic moment of the particle and the dimensions of the zone of allowed motion in the radial and axial directions. If the particle moves in the direction of a monotonic variation of H, the maxima and minima of $r(z)$ decrease monotonically if the particle moves in the direction of increasing H and increase monotonically if the particle moves in the direction of decreasing H. (auth)

12666 INTERACTION OF A RUNNING ELECTROMAGNETIC WAVE WITH A BEAM OF CHARGED PARTICLES. Zhileiko, G. I. (Moscow Power Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 988-90(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1242-4(Jun 1972).

The equations for the interaction of a beam of charged particle with the field of a running electromagnetic wave are transformed in order to construct a synthesis problem. Given the parameters of the beam or of the field at the exit of the interaction system (the slow-wave system), the parameters of the waveguide are to be determined. This study is applicable to waveguide accelerators of electrons and protons and also to traveling-wave tubes. (auth)

12667 PHASE-ENERGY EQUATIONS FOR A HIGH-CURRENT LINEAR ACCELERATOR AND SYNTHESIS OF AN ACCELERATING WAVEGUIDE STRUCTURE. Zhileiko, G. I.; Sindinskii, V. V. (Moscow Power Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 991-4(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1245-9(Jun 1972).

Phase-energy equations are derived for a linear accelerator. Given the output parameters of the beam, these relations can be used to find the characteristics of an accelerating waveguide, namely, the conductivity and the phase velocity. The dimensions of the waveguide are calculated from these data. (auth)

12668 VARIATIONS IN THE AVERAGE ELECTRON ENERGY IN THE FIELD OF A PLANE WAVE, ALLOWING FOR RADIATIONAL FRICTION. Khalilov, V. R.; Kholomai, B. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 4, 425-30 (1972). (In Russian).

The problem of the motion and radiation of an electron in the field of a plane electromagnetic circularly polarized wave was examined. Equations of motion were obtained which describe the change in quantum numbers characterizing the state of the electron in the wave. Quantum recoil effects during photon emission were accounted for. At $\hbar \to 0$, the solution found passed over into the corresponding classical one. The question as to the change in the average energy of the electron was discussed. (tr-auth)

12669 CONTRIBUTION TO THE KINEMATIC THEORY OF MULTISTAGE BUNCHING OF CHARGED PARTICLES. Petrosyan, M. L. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 4, 645-8(Apr 1972).

Translated from Radiotekh. Elektron.; 17: No. 4, 826-9(Apr 1972).

Multi-stage single-frequency bunching in the case when the number of stages is infinite is discussed. It is shown that parameters of the stages can be chosen to obtain perfectly narrow bunching (bunching into one point). (auth)

12670 FOCUSING OF CHARGED PARTICLES IN A COMBINATION BIHELICAL SYSTEM WITH A UNIFORM MAGNETIC FIELD. Trotsyuk, N. I. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 4, 656-9(Apr 1972).

Translated from Radiotekh. Elektron.; 17: No. 4, 841-4(Apr 1972).

The focusing of charged particles in a combination bihelical system, along the axis of which there is a uniform magnetic field, is examined. The differential equations of the paraxial trajectories and their solutions are found. On the basis of an analysis of the solutions it is concluded that such a system can be used to form long beams of charged particles, to sort particles of the same mass and same charge in terms of their energies, and to sort particles which have traversed the same accelerating potential difference in terms of their specific charages. By means of this system one can obtain an undistorted image of a flat object, the plane of which is perpendicular to the system axis. The image has the same dimensions as the object, but is turned with respect to the object. Movement of the image can be observed. (auth)

12671 SPACE CHARGE FIELD EFFECTS ON THE EFFICIENCY OF CYCLOTRON INTERACTION OF A TUBULAR ELECTRON FLUX WITH A CIRCULAR WAVE GUIDE AND A FIELD H_{01}. Kovalev, I. S.; Kuraev, A. A.; Demidovich, E. M.; Shevchenko, F. G. (Minsk Radiotechnical Inst.). Dokl. Akad. Nauk BSSR; 16: No. 9, 791-4(Sep 1972). (In Russian).

The interaction of a tubular axially symmetrical spiral electron flux at cyclotron resonance with waves of H_{01} type was examined near the cut-off frequency. During an approximation of supercritical waves in the form of resolving into a graduated series near the sources, the initial boundary problem reduced to a two-point problem of the fourth order. The field of the supercritical waves in the first approximation was characterized by a dimensionless parameter of space charge S. Numerical results are adduced. The optimum value S_{opt} for the variant under study was 0.69; the corresponding increased efficiency $\Delta\eta \sim 20\%$. (tr-auth)

12672 GAS FOCUSING OF A HIGH-CURRENT ELECTRON BEAM. Agofonov, A. V.; Lebedev, A. N. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1140-3(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 11432-36(Jul 1972).

Nonstationary pinching of a strong electron beam with zero emittance in a low-pressure gas is considered. An analytic solution is obtained for the case of a constant number of ions when the beam undergoes periodic oscillations. The effect of slow accumulation of ions on the amplitude and frequency is investigated. The initial stage of pinching is analyzed by numerical methods. The range of initial transverse electron velocities and gas pressures corresponding to stability is found from the beam criterion (tenfold size increase). The time dependence of the initial beam density is shown graphically for different gas pressures and initial transverse velocities. (auth)

Storage Rings

12673 (BNL-17455) INJECTION INTO THE ISA: ENERGY STACKING. Month, M. (Brookhaven National Lab., Upton, N. Y.). 5 Dec 1972. 15p. Dep. NTIS.

Details of a scheme for injection into the ISA are given. The basic idea, as proposed for the ISA by Keil and Sessler, is one which is presently used to stack the ISR at CERN. A stack is built by injecting a pulse, moving the injected beam by rf acceleration across a septum into an area for the parked stack and storing the beam here. The septum protects the stack from the injection kick. The stacked beam is then rebunched and accelerated to 200 GeV. The method proposed here involves the following steps: 1) With an ISA circumference three times the AGS circumference, three AGS pulses are injected into the ISA by direct transfer. The AGS bunches are modified and matched into a stationary bucket in the ISA. 2) The 36 bunches in the ISA are accelerated to the stacking orbit. Since all 36 buckets are utilized, the technique of suppressed buckets is not needed. The voltage and stable phase are conceived as programmed so as to optimize the stacking procedure, which means for the most part to minimize the dilution of longitudinal phase space. At this stage, the implications of longitudinal instabilities in a coasting beam are discussed. 3) The stack is rebunched and accelerated from its initial 30 GeV to its final 200 GeV. The capture procedure and final beam characteristics are discussed. The implications for acceleration times, voltage requirements, aperture and energy spread are also considered. The significant conclusions are: a) No problems with longitudinal instabilities in the AGS. b) Thirty stacking cycles (90 AGS pulses) are employed. This requires that the AGS produce 8.3×10^{12} protons per pulse and leads to 15 Amps in the ISA. The stacking time is about 3 seconds per cycle. The impedance tolerance for longitudinal instabilities in the full coasting stack is 10 ohms and may be attainable. c) The aperture required in the normal lattice segments is 22 mm. d) The accelerating voltage required is about 60 kV/turn. Acceleration, if done with energy increments of 10.4 keV/turn takes about 128 seconds to get to 200 GeV and produces a bunched beam of momentum spread, $\Delta p/p = \pm 8.2 \times 10^{-4}$, which by adiabatic debunching could be reduced to $\Delta p/p = \pm 4.7 \times 10^{-4}$. (auth)

12674 (BNL-17461) TOLERANCES FOR BENDING MAGNETS IN A SUPERCONDUCTING STORAGE ACCELERATOR. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). 5 Dec 1972. 8p. Dep. NTIS.

Tolerances for the magnetic field of the bending magnets in a superconducting storage accelerator are proposed. Previous suggestions for the tolerances are reconsidered and revised. The tolerances are based partly on orbit requirements and partly on what appears doable with the cosine bending magnet. Systematic errors in the magnetic field, and random errors in the magnetic field, are considered. (auth)

12675 (LRL-905) CORNER SEPTUM MAGNET FOR MULTITURN INJECTION. Avery, R. T.; Meads, P. F. Jr. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 4p. (CONF-720908-27). Dep. NTIS.

From fourth international conference on magnet technology, Upton, NY (19 Sep 1972).

A system is described for compactly injecting 25 or more turns into a strong-focusing ring by simultaneous multiturn injection into both horizontal and vertical betatron phase space. The key element is a novel "corner" septum magnet, which introduces the beam at a location displaced both radially and vertically from the equilibrium orbit and incorporates a thin current-carrying septum on one face and a thin flux-carrying septum on the adjacent face. (4 figures, 1 table) (auth)

Experimental Facilities

Refer also to abstracts 12073, 12213, 13167, and 13450.

12676 (ANU-P-559) REPORT OF COMMITTEE ON DATA ACQUISITION FACILITIES FOR THE 14UD ACCELERATOR. PART 1. PROCESSORS AND PERIPHERALS. Bell, R. A. I.;

Hay, H. J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Aug 1972. 26p. Dep. NTIS (U. S. Sales Only).

Anticipated requirements and a recommendation for a data acquisition system based on two Hewlett–Packard 2100A central processors at ANU are given together with an alternative system based on two PDP 11/40 central processors. (Australia)

12677 (BNL–17311) MAGNETIC CIRCUIT CONSIDERATIONS FOR HIGH FIELD MAGNETS. Allinger, J. E.; Danby, G. T.; Jackson, J. W.; Lin, S. T. (Brookhaven National Lab., Upton, N. Y.). 1972. 5p. (CONF-720908–20). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

The iron-window-frame approach to high-field dipole magnet design is described. This approach approximates the dipole field between extended parallel current sheets. Very high field uniformity is possible at all obtainable excitations, provided an auxiliary correcting coil circuit is used above ~20 kG. Two-dimensional field computations using known permeability data are used for precision optimization of the circuit design. Comparisons of computed fields with model-magnet experimental results are given. Some calculations of high-field iron-core quadrupole properties are also briefly considered. (5 figures, 1 table) (auth)

12678 (BNL–17312) PERFORMANCE AND MAGNETIC MEASUREMENTS OF A FULL SCALE CROSS-SECTION MODEL OF A SUPERCONDUCTING 8° BENDING MAGNET SYSTEM. Allinger, J.; Danby, G.; DeVito, B.; Foelsche, H.; Gibbs, R.; Hsieh, S.; Jackson, J.; Prodell, A.; Raag, A. (Brookhaven National Lab., Upton, N. Y.). 1972. 7p. (CONF-720908–21). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

A 20-in. long, full-scale cross-section model of a superconducting 8° bending magnet was constructed and tested at Brookhaven National Laboratory. A description of the model magnet and test assembly is given, and field measurements and magnet performance are discussed. (6 figures, 3 tables) (auth)

12679 (BNL–17313) STUDIES OF LOSSES, DIAMAGNETIC AND PERMANENT MAGNETIC EFFECTS IN SUPERCONDUCTING MAGNETS. Danby, G.; Foelsche, H.; Hsieh, S.; Jackson, J.; Prodell, A. (Brookhaven National Lab., Upton, N. Y.). 1972. 5p. (CONF-720908–22). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

Extensive measurements of superconducting properties of model magnets employing various materials and coil construction techniques were made. Superconductors of varying properties were used, and loss measurements are given as a function of maximum field and rate of rise. Diamagnetic effects for various coil configurations, strand sizes, Cu/SC ratio, etc., were investigated, as well as the effect of magnetic circuit geometry on these properties. The rate dependence of diamagnetic effects and their magnitudes in the aperture of magnets is presented. The other related hysteretic property of superconductors, remanent magnetization, was investigated for various models and SC material parameters. The impact of magnetic circuit geometry on remanence both within coils and within magnet apertures was studied. Among these results are the effects of strand size and critical current density, cycle history, and geometry. Studies of procedures to minimize remanent magnetization are also presented. (5 figures, 4 tables) (auth)

12680 (CONF-721202–4) LIST OR SORT? SOME EXPERIENCE WITH THE ORIC MULTIPARAMETER DATA ACQUISITION SYSTEM. Hensley, D. C. (Oak Ridge National Lab., Tenn.). 1971. Contract W-7405-eng-26. 13p. Dep. NTIS.

From Nuclear science symposium and exhibits: nuclear instrumentation for research and development; Miami Beach, FL (6 Dec 1972).

The data acquisition system at the ORIC is reviewed, and several of the data acquisition techniques used are described. The experience of two years of data acquisition with the system is discussed, and a special effort is made to assess the merits and capabilities of an associative memory technique. A current development in the programs for data acquisition is sketched, and a simple graphics technique for line printers is presented which permits plotting 3 data points per line. (8 figures) (auth)

12681 (KFK–1631) COUPLING OF HIGH FREQUENCY OUTPUT IN SUPERCONDUCTING DEFLECTING RESONATORS FOR A PARTICLE SEPARATOR. Eschelbacher, H. C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jun 1972. 95p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe (West Germany).

The coupling of RF-power into superconducting cavities in the GHz-region with Q-values of 10^8 to 10^{11} is discussed. The RF-power required is very small but additional losses occur in the coupling system which can limit the superconducting performance of the cavity. A superconducting variable coupling system was developed which is cooled by liquid helium. Measurements and calculations yield the coupling losses of this system to be of the order of 10^{-10}. Measurements of the field enhancement at the edges of the coupling hole were performed by use of perturbation methods. A procedure is described to compensate this field enhancement by a treatment of the flatness of the deflecting structure. (auth)

12682 (LA–5126) MAGNET ALIGNMENT STUDY FOR THE LAMPF BIOMEDICAL PION CHANNEL. Hutson, R. L. (Los Alamos Scientific Lab., N. Mex.). Jan 1973. Contract W-7405-eng-36. 9p. Dep. NTIS.

Magnet alignment tolerances for the LAMPF Biomedical Pion Channel are specified, and the effects of misalignment are discussed. (3 figures, 5 tables) (auth)

12683 (LA-DC–72–1119) SPECTROMETER DESIGN AT LASL. Thiessen, H. A.; Klein, M. M. (Los Alamos Scientific Lab., N. Mex.). [nd]. 26p. (CONF-720908–12). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY. (19 Sep 1972).

The results of recent work at Los Alamos in the area of spectrometer design are reviewed. Included are reports of results of bending magnet design using H_t-windings for fine adjustment of the field uniformity, high quality quadrupole design, and high resolution detectors. Details of an optimizing ray tracing program called MOTER are discussed and several recent results obtained with this program are given. The techniques reported represent significant developments in the technology of spectrometer design and have important applications in the areas of medium energy and high energy physics. (auth)

12684 (LA-DC–72–1364) NEUTRON FLUX SPECTRA AT LAMPF FOR CTR RADIATION DAMAGE STUDIES. Dudziak, D. J.; Sherman, M. A. (Los Alamos Scientific Lab., N. Mex.). 1972. 23p. (CONF-721111–6). Dep. NTIS.

From international meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

Calculations were made of neutron flux spectra from potential beamstop materials in the CTR radiation damage experimental cavity at the Los Alamos Meson Physics Facility (LAMPF). Spectra from beryllium, carbon and aluminum had high-energy components ($E \geq 10$ MeV) ranging from 1.6% of the total flux at 90 to 180° from the incident proton beam axis to 15.6% at 0 to 30°. Computed helium-production to atom-displacement rate ratios in niobium varied between 0.4 and 1.4 ppM/dpa, compared to 1.6 for a θ-pinch fusion reactor first wall. Interaction proton energies used in the calculations were 400 and 750 MeV. The beam at LAMPF will have an incident energy at the stop of ~750 MeV. (auth)

12685 (LBL–911) DESIGN OF THE HIGH RESOLUTION SPECTROMETER BENDING MAGNETS FOR LASL. Hoyer, Egon; Gunn, Jack (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 8p. (CONF-720908–26). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY (19 Sep 1972).

The bending magnet design of the LAMPF High Resolution Spectrometer is presented. Design requirements and considerations are given. The novel magnetic design of the central portion and ends of the magnet is briefly explained. Magnet parameters and mechanical design features are discussed. (auth)

12686 (LBL–1222) EDGE COOLED TAPE MAGNET COILS FOR HIGH CURRENT DENSITY APPLICATIONS. Main, R. M.; Yourd, Roland (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1972. Contract W-7405-eng-48. 19p. (CONF-720908–29). Dep. NTIS.

From 4th international conference on magnet technology; Upton, NY (19 Sep 1972).

The LBL HILAC group has had seven years' experience in the design, fabrication, and use of magnets using edge-cooled tape coils. The high packing factor (90%) achievable with these coils is obviously advantageous, with the problem of producing reliable and long-lived cooling plate–coil thermal bonds as the major detraction. Fabrication techniques for the solution of this problem have been developed and fully tested. Designs specifically applicable to the use of tape coils were developed for quadrupole,

circular, beam bending, and beam distribution magnets. These magnets are considerably smaller and lighter and require less power than magnets using conventional hollow-conductor coils. In addition, the coolant circuitry, current terminals, and coil-retaining mechanisms are extremely simple. The design criteria and cost analysis are developed, and details of the design and fabrication techniques are discussed. Limitations to the applicability are also indicated. (9 figures, 2 tables) (auth)

12687 PROTON POLARIZATION IN ALCOHOLS AT 50 kG, 1 K. Hartmann, G.; Hubert, D.; Mango, S.; Morehouse, C. C.; Plog, K. (DESY, Hamburg). Nucl. Instrum. Methods; 106: No. 1, 9-12(1973).

Proton polarization, $P_n \approx 80\%$, polarization build-up times, $\tau_n \approx 2$ min, and relaxation times, $T_n \approx 40$ min, were repeatedly obtained at 1°K and 50 kG in 1-butanol– and 1-pentanol–water mixtures doped with porphyrexide. Shorter (or longer) T_n's and τ_n's can be obtained by varying the target composition when a certain loss in polarization is acceptable. (6 figures) (auth)

12688 PARAXIAL CHROMATIC ABERRATION OF ASYMMETRIZED QUADRUPOLE LENSES. Szabo, Gy. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instrum. Methods; 106: No. 1, 61-4(1973).

An investigation on paraxial chromatic aberration of combined asymmetrized quadrupole lenses is described. It is shown that for combined lenses the achromatism can be obtained also in the case of asymmetrization, while for electrostatic or magnetic doublets the deflection can be independent of the particle energies. (1 figure) (auth)

12689 HIGH-PRESSURE GAS TARGET FOR MESIC X-RAY MEASUREMENTS. Springer, K. (Technische Univ., Munich). Nucl. Instrum. Methods; 106: No. 1, 65-75(1973).

The construction of a gas target which stands a pressure of 1000 atm is described. This vessel is useful to measure x rays of gaseous elements in admixture with hydrogen. The mesic x rays of the gas with $Z > 1$ are measured with Ge(Li) detectors due to the meson transfer from hydrogen to the admixture under investigation. These admixtures are in a ratio of $\geq 10^{-5}$ by volume. (13 figures, 4 tables) (auth)

12690 BEAM PROFILE MEASURING DEVICE AND FOCUSING AID. Kistner, O. C. (Brookhaven National Lab., Upton, NY). Nucl. Instrum. Methods; 105: No. 3, 603-4(1972).

A system is described for observing the profile of an accelerator beam, which is particularly useful at positions where the beam cross section is large, such as near quadrupole focusing elements. The system also offers the possibility of observing the profile of a particular charge–state fraction of a heavy-ion beam at positions before the analyzing magnet. (1 figure) (auth)

12691 FAST METHOD FOR TARGET THICKNESS DETERMINATION. Ewen, K.; Gonsior, B. (Univ., Cologne). Nucl. Instrum. Methods; 105: No. 3, 599(1972). (In German).

A quick method is described for the measurement of target thickness with errors less than 10%; the method is based on the apparent threshold-energy shift in (p,n) reactions due to the energy loss in the target. (1 figure) (auth)

12692 TRITIUM AND DEUTERIUM IMPREGNATED TARGETS FOR NEUTRON GENERATORS. Stark, Donald Sutherland (to National Research Development Corp.). U. S. Patent 3,683,190. 8 Aug 1972. Priority date 20 Feb 1968, Great Britain.

In rare-earth neutron targets, there is a tendency for the hydrided rare-earth film to flake off the metal substrate because of the formation of the brittle trihydrides. The present invention provides targets which alleviate this difficulty. In these novel targets there is located between the substrate and the hydrided rare-earth film an intermediate film of a further metal, the further metal being selected to diffuse readily into the metal of the first-mentioned film under solid-state conditions and form a solid solution or compound therewith, and to adhere well to the substrate, and being sufficiently thin not to reduce substantially the absorption of hydrogen by the first-mentioned film by dilution of the first-mentioned film. Suitable intermediate films include nickel and gold. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 12082, 12083, 12085, 12151, 12170, 12171, 12173–12182, 12184, 12942, 13037–13043, 13050–13054, 13077, 13182, 13183, and 13478.

12693 (JPRS–57913) "INTERKOSMOS" SATELLITES STUDY COSMIC RAYS. Grigorov, N. L.; Vakulov, P. V. Translated from Priroda; No. 10, 29-36(1972). 17p. NTIS.

The report contains a review of cosmic ray studies conducted with the Interkosmos satellites. (JPRS)

12694 (N–72-22804) SOLAR-DIURNAL VARIATIONS OF COSMIC RAYS FROM THE MAXIMUM TO THE MINIMUM OF SOLAR ACTIVITY. Dorman, L. I.; Kolomeets, E. V. Translated from Kosm. Luchi; No. 9, 1-109(1968). 169p. (NASA-TT-F-690). NTIS.

The planetary distribution and energy dependence of the first and second harmonics of the solar-diurnal variation of cosmic rays in the quiet and disturbed periods are analyzed according to the data of the world network of neutron monitors for the observation period 1957 to 1964, i.e., for the period from the maximum to the minimum of solar activity. The anisotropy of cosmic rays is a sensitive characteristic of the changing conditions in interplanetary space. On the basis of the obtained data, a critical analysis is conducted of the mechanisms which cause anisotropy of the galactic cosmic rays in the solar system. A model of the solar-diurnal variations of cosmic rays is developed from the theory of anisotropic diffusion of particles on the moving irregularities of the interplanetary magnetic field in the presence of a regular field, with different directions of the field with force lines in the form of the Archimedes spirals. (auth)

12695 (UCB–34-P-32-PR-7) MASS SPECTROSCOPY RESEARCH. Progress Report. (California Univ., Berkeley. Dept. of Physics). 15 Sep 1972. Contract AT(04-3)-34. 18p. Dep. NTIS.

Work accomplished during 1971-72 is briefly reviewed and work in progress is discussed. Work in Portugal on setting up a geochronology lab is described in some detail. Research plans for 1973 are given. (WDM)

12696 STUDY ON THE ISOTOPIC COMPOSITION OF LOW-ENERGY BORON, CARBON, NITROGEN, AND OXYGEN COSMIC-RAY PARTICLES. Beaujean, R., Enge, W. (Univ., Kiel). Z. Phys.; 256: No. 5, 416-40(1972). (In German).

In eight cellulose nitrate sheets of a plastic detector stack flown in 1968 from Ft. Churchill at 1.8 g/cm^2 floating altitude, stopping heavy cosmic-ray particles of about 100 MeV/Nuc were measured. In 0.2 m^2 of the 1.6 m^2 large stack 30 boron, 190 carbon, 83 nitrogen, and 263 oxygen particles were analyzed. A resolution of $\Delta Z = \pm 0.1$ charge units and $\Delta M = \pm 0.7$ mass units was obtained. Using oxygen particles for a calibration at ^{16}O the mean values of the mass distributions of the other elements are: 10.79 ± 0.17 for boron, 12.22 ± 0.8 for carbon, 14.61 ± 0.12 for nitrogen. (auth)

12697 SOME SOURCES OF ERROR IN DETERMINING THE EXPONENT OF THE PION PRODUCTION SPECTRUM AND ALSO IN THE CHARGE RATIO AT SEA-LEVEL. Appleton, I. C.; Rostin, B. C. (Univ. of Nottingham, Eng.). pp 1335-9 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The effect on the value of the exponent (γ) of the pion production spectrum of sample size as well as incorrect estimates of either the scattering in the material of the spectrometer or the maximum detectable momentum (m.d.m.) of the instrument were investigated. Data are presented which indicate that large errors can be introduced if scattering in the apparatus is over or underestimated. It is also shown that an incorrect value assigned to the m.d.m. results in a large value of χ^2 and the corresponding increase in the significance level associated with the value of γ. The importance of sample size on the measurement of the positive–negative ratio was also investigated and this showed that large systematic errors are introduced if experimental results of inadequate statistical accuracy are used as the basis for theoretical deduction. (auth)

12698 RIGIDITY SPECTRUM OF HELIUM NUCLEI ABOVE 17 GV AND A SEARCH FOR HIGH ENERGY ANTI-NUCLEI IN PRIMARY COSMIC RAYS. Verma, R. P.; Rengarajan, T. N.; Tandon, S. N.; Damle, S. V.; Pal, Y. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 240: No. 102, 135-7(11 Dec 1972).

Some results are described that were obtained with a magnet spectrograph flown from Hyderabad (geomagnetic cutoff ~17 GV) in May 1970. The two principal results are that no anomaly was found in the differential spectrum of helium nuclei close to the geomagnetic cutoff, and that no anti-nuclei were seen up to a rigidity of ~100 GV. The apparatus and its mode of operation are described in detail, and rigidity spectra obtained are shown. No evidence was found for a deficiency of particles near the geomagnetic cutoff. Since the deflection of particles in a magnetic field was measured, anti-nuclei, if present, would have been seen. (UK)

12699 RESTRICTED DIFFUSION MODEL OF COSMIC-RAY PROPAGATION. Sitte, K. (Univ., Freiburg i.B.). Lett. Nuovo Cim.; 5: No. 6, 483-9(7 Oct 1972).

A simple model of restricted diffusion, derived from the basic ideas of Jokipii and Parker (1969) but with parameters which lead to an energy-dependent disk lifetime, is presented. The implications of halo propagation, if a permanent halo does exist, are also reviewed. (WDM)

12700 UNORTHODOX IDEAS CONCERNING THE ORIGIN OF COSMIC RADIATION. Sitte, K. (Univ., Freiburg i. B.). Lett. Nuovo Cim.; 5: No. 16, 1033-7(16 Dec 1972).

The difficulties inherent in the theory of pulsar origin of cosmic radiation are briefly reviewed. Two other possibilities for the origin of cosmic radiation are considered: the assumption of extragalactic origin of the bulk of cosmic radiation and the cosmic-ray big-bang theory. (WDM)

12701 MODEL FOR THE BREAK IN THE PRIMARY COSMIC-RAY ENERGY SPECTRUM AT ~10^{15} eV. Naranan, S. (Tata Inst. of Fundamental Research, Bombay). Lett Nuovo Cim.; 5: No. 12, 817-23(18 Nov 1972).

The possibility is examined that the change in the primary cosmic-ray spectrum at ~10^{15} eV arises from a change in the hadron interaction characteristics of high-energy cosmic rays with matter in the volume where they are accelerated by a Fermi-type mechanism. (WDM)

12702 12th INTERNATIONAL CONFERENCE ON COSMIC RAYS, HOBART, AUSTRALIA, AUGUST 16–25, 1971. VOLUME 4. Hobart, Australia; International Union of Pure and Applied Physics (1971). 392p. (CONF-710807-(Vol.4)).

Sixteen papers deal with high-energy interactions including quark detection experiments. Five of these are given separate abstracts; the remainder appear only in abstract form. Fifty-six papers deal with muons and neutrinos in cosmic rays including appropriate accelerator results. Thirty two of these are given separate abstracts; the remainder appear only in abstract form. Forty-three papers deal with techniques applicable to cosmic-ray investigations; 26 of these are given separate abstracts and the remainder are in abstract form only. (Australia)

For abstracts of individual papers see: 12080–12086, 12151, 12169–12184, 12703–12723, 13036–13044, 13050–13054, 13077, 13182, 13183, and 13266.

12703 ANGULAR AZIMUTHAL DISTRIBUTIONS OF HIGH ENERGY COSMIC RAYS IN LUNAR SILICATE MINERALS. Van Loon, L. G. (Univ. of New South Wales, Kensington, Australia). pp 1292-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Distributions of primary and secondary cosmic rays were measured in randomly oriented planes in brown glassy silicate minerals from a lunar rock of about 10 cm size. The distribution to May 21, 1971 was found to be 23, 15, 20, 17, 11, 7, 36, 25 for a $\pi/8$ rd binned semicircle. Annealing tests show that track densities reduce gradually to 900°C, whilst at 130°C they remain. Some of these tracks give patterns reminiscent of $\pi^\circ \rightarrow \gamma\gamma$ and cascades to about 100,000 GeV. It may thus be possible to make a map of the galactic cosmic rays. (auth)

12704 RATIO OF NEUTRAL TO CHARGED HADRONS IN COSMIC RAYS. Vishwanath, P. R.; Jones, L. W. (Univ. of Michigan, Ann Arbor). pp 1298-1300 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The ratio of neutral to charged cosmic-ray hadrons was measured at 100 to 200 GeV and at 200 to 500 GeV as 0.63 ± .07 and 0.70 ± .11, respectively. Assuming p: n = 1.2, these values correspond to a pion: proton ratio of 0.33 ± .14 and 0.19 ± .16, respectively. Although local anticoincidence counters may suppress these ratios, the results are in good agreement with other determinations. (auth)

12705 INVESTIGATION OF THE HADRONIC COMPONENT OF COSMIC RAYS. Baruch, J. E. F.; Brooke, G.; Kellerman, E. W. (Univ. of Leeds, Eng.). pp 1301-6 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The performance was studied of a 4-m^2 calorimeter employing proportional counters in a crossed pattern and surrounded by air shower detectors. The apparatus was found capable of determining the energies of single and of the individual components of multiple hadronic events with adequate resolution in the range 10^{12} to 10^{14} eV and of relating these nuclear events to the size of accompanying showers. (auth)

12706 ABSOLUTE INTENSITIES OF COSMIC RAY MUONS ABOVE 3.48 AND 7.12 GeV/c. Ayre, C. A.; Hamdan, M. A.; Holroyd, F. W.; (and others) (Univ. of Durham, Eng.). pp 1309-13 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Absolute intensities of cosmic-ray muons in the near vertical direction with momenta about 3.48 and 7.12 GeV/c were determined with the new Durham spectrograph MARS. The intensities were found to be close to those previously reported by Aurela and Wolfendale (1967), the present intensities being higher by some (7.7 ± 1.3)% and (1.7 ± 1.4)% at the respective momenta. A comparison is made with the results of other recent measurements. (auth)

12707 ABSOLUTE VERTICAL MUON SPECTRUM AT SEA LEVEL IN THE MOMENTUM RANGE 0.2 TO 1000 GeV/C. Allkofer, O. C.; Carstensen, K.; Dau, W. D. (Univ., Kiel). pp 1314-18 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The experimental results of 3 different spark chamber spectrographs (momentum range 0.2 to 6 GeV/c, 0.2 to 10 GeV/c, 10 to 1000 GeV/c) and of one absorption spectrograph (1.11 GeV/c) were used to determine the absolute vertical muon intensity in the momentum range 0.2 to 1000 GeV/c in Kiel. A best fit calculation of this absolute spectrum gives the differential and integral intensities, and the corresponding slopes at standard momenta. The differential flux of the absolute spectrum exceeds the HW-spectrum (Hayman 1962), the HW-spectrum being lower by 25%. Concerning the integral flux the OWP-spectrum (Osborne 1964) is lower by 20% at 20 GeV/c and 2 to 10% at 1 TeV. (auth)

12708 MUON MOMENTUM SPECTRA AND POSITIVE–NEGATIVE RATIOS AT SEA LEVEL IN THE ENERGY RANGE 10 TO 1500 GeV. Allkofer, O. C.; Carstensen, K.; Dau, W. D.; (and others) (Univ., Kiel). pp 1319-24 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The muon momentum spectra and charge ratios at sea level in the vertical direction and at 83° zenith angle were measured with the Kiel cosmic-ray spectrograph in the momentum range from 10 to 1500 GeV/c. The crossing over of both integral spectra was found at 100 GeV/c. The ratio of integral intensities I(83°)/I(0°) approached sec 0 at high energies and was consistent with a pure meson production model of muons up to 1 TeV. In the vertical direction the integral charge ratio above 10 GeV/c was 1.29 ± 0.02, a minimum was indicated at about 100 GeV/c. Beyond 40 GeV/c the positive–negative ratio at 83° amounted to 1.25 ± 0.05. (auth)

12709 INVESTIGATION OF THE ABSOLUTE INTENSITY OF MUONS AT SEA-LEVEL. Crookes, J. N.; Rastin, B. C. (Univ. of Nottingham, Eng.). pp 1325-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

An instrument involving a Geiger counter telescope coupled with two crossed neon flash tube arrays was used to measure the vertical absolute intensity of muons at sea-level. The apparatus is capable of being orientated at different zenith and azimuthal angles. Hence absolute muon intensities were also determined at zenith angles of 45, 60, and 80° in the magnetic N–S azimuth. (auth)

12710 DETERMINATION OF THE MUON SPECTRUM AND POSITIVE–NEGATIVE RATIO AT SEA-LEVEL USING MONTE CARLO TECHNIQUES. Appleton, I. C.; Rastin, B. C. (Univ. of Nottingham, Eng.). pp 1329-34 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Monte-Carlo calculations were made to determine the muon momentum spectrum and positive–negative ratio at sea-level. These calculations involved the use of an Isobar Model for NN collisions as well as a Thermodynamic Model of πN and KN interactions. Preliminary results on the momentum spectrum are presented which show good agreement with experimental data at momenta in excess of 10 GeV/c. The variation of the charge ratio with momentum however was grossly at variance with the experimental data below 50 GeV/c, and fluctuated rather arbitrarily in the range 50 to 1000 GeV/c. (auth)

12711 FINE STRUCTURE IN THE MUON SPECTRUM AT LARGE ZENITH ANGLES. Tebb, R. G. P.; Nash, W. F.; Deacon, C. A. (Univ. of Nottingham, Eng.). pp 1340-5 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The 37,000 muon trajectories so far obtained with the Nottingham inclined spectrometer in the angular range 78 to 84° were analyzed as a function of energy and zenith angle. There was some evidence for a maximum in the charge ratio at ~25 GeV, which tended to increase with zenith angle. These results are compared with other relevant data. (auth)

12712 SURVEY OF LARGE ZENITH ANGLE MUON DATA AT HIGH ENERGIES. Flint, R. W.; Nash, W. F. (Univ. of Nottingham, Eng.). pp 1346-52 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A survey is presented of muon spectrum charge ratio measurements made with large zenith angle sea-level spectrometers and underground telescopes, with particular reference to results from the Nottingham Spectrometer. Production of the sea level muons via long-lived secondary particles is found to explain adequately the majority of the results described. (auth)

12713 FURTHER OBSERVATION OF THE COSMIC RAY MUON SPECTRA AND THE CHARGE RATIO AT LARGE ZENITH ANGLES. Kamiya, Y. (Tokyo Univ.); Kawaguchi, S.; Iida, S. pp 1354-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Further observation of the momentum spectra and the charge ratio of cosmic-ray muons was carried out by means of a magnetic spectrometer, of which the maximum detectable momentum is 1090 GeV/c. A total of 25,000 particles incident from the zenith angle range 80 to 90° were analyzed and it is shown that; (1) the differential momentum spectra as a function of zenith angles agree with the calculation that the sea-level cosmic-ray muons are daughters of pions and kaons generated by the interaction of cosmic-ray primaries and air nuclei, (2) the results of the energy dependence of the charge ratio are found to be approximately constant in the range from 10 to 1000 GeV/c, that is, $R = N(\mu^+)/N(\mu^-) = 1.241 \pm 0.006$. (auth)

12714 COSMIC RAY MUON CHARGE RATIO MEASUREMENTS ABOVE 1 TeV. Ashley II, G. K.; Keuffel, J. W.; Larson, M. O. (Univ. of Utah, Salt Lake City). pp 1359-63 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The charge excess of cosmic-ray muons whose energy at production is in the 1 to 10 TeV range is currently being measured using the Utah detector. The results of these measurements are used to test the validity of the proposed model for an isotropic production process to explain the Utah underground muon deficit at large

zenith angles. The results statistically favor the isotropic production process. (auth)

12715 PRELIMINARY MUON SPECTRUM AND CHARGE RATIO FROM M.A.R.S. Ayre, C. A.; Hamdan, M. A.; Hume, C. J.; (and others) (Univ. of Durham, Eng.). pp 1364-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Results are presented of a preliminary measurement of the vertical muon spectrum and charge ratio at sea level in the momentum range 10 GeV/c to 700 GeV/c using the Durham spectrograph—MARS. The results are based upon the analysis of 7000 events above 10 GeV/c. The spectrum measurement is in agreement with previous results. The mean value of the charge ratio over the momentum range is 1.29 ± 0.03. (auth)

12716 INVESTIGATION OF THE ABSOLUTE INTENSITY OF MUONS AT 31.6 hg cm^{-2} BELOW SEA-LEVEL. Crookes, J. N.; Rastin, B. C. (Univ. of Nottingham, Eng.). pp 1369-73 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The location of a cave below Nottingham Castle affords a suitable site for measuring the intensity of muons in not only the vertical direction but also at zenith angles up to about 70° in the N–S azimuth. The apparatus described previously (Intensity at Sea-Level) was used to measure the muon intensity for zenith angles of 30, 45, and 60°. This data was compared with the results of other workers and the best fit curve of the variation of the exponent n with depth representing the available data was found. (auth)

12717 VERTICAL MUON INTENSITIES AT THE UTAH SITE. Cassiday, G. L.; Gilbert, P. C.; White, D. M. (Univ. of Utah, Salt Lake City). pp 1375-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

In order to test the possibility of explaining the Utah effect on the basis of rock density anomalies, a portable cosmic-ray telescope was set up at five different locations under the beam line of the large Utah cosmic-ray detector. The mean rock density above each station could be accurately inferred from the observed vertical intensity. The average value obtained is $\rho = 2.55 \pm 0.04$ g/cm^3. Moreover, if world-survey vertical intensities based on this density are combined with the Utah data, the existence of an isotropic muon component is substantiated. (auth)

12718 MEASUREMENTS ON THE INTENSITY OF COSMIC RAY MUONS AT 10^{13} eV WITH EMULSION CHAMBER UNDERGROUND. Mizutani, K. (Saitama Univ., Urawa, Japan); Shirai, T.; Akashi, M.; Watanabe, Z. pp 1392-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

By means of the emulsion chamber exposed at the underground laboratory, muon-induced showers were observed. By analyzing these showers, the energy spectrum and the zenith angle distribution of cosmic-ray muons are obtained in the energy range 1 TeV to 10 TeV. (auth)

12719 MUON BUNDLES AT 40 M.W.E. Bergamasco, L. (CNR, Turin); Castagnoli, C.; D'Ettorre, B.; (and others). pp 1404-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

An investigation on the muon bundles is presently being carried out at a depth of 40 m.w.e. using two large-area range telescopes. Each of them consists of six bigap spark chambers alternate with 5 cm lead layers and of two scintillation counters at the top and the bottom (total absorbing thickness 450 gr. cm^{-2}). The preliminary results on the distribution of the relative distances between the trajectories of the multiple particles traversing either telescope are compared with the expected statistical distribution given by the EAS muonic component. (auth)

12720 ZENITH ANGLE DEPENDENCE OF COSMIC RAY MUONS. Bergeson, H. E.; Bolingbroke, G. L.; Carlson, G.; (and others) (Univ. of Utah, Salt Lake City). pp 1418-22 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

The zenith angle distribution of high-energy cosmic-ray muons was further investigated using a sample of $2 \cdot 10^5$ muons observed in the Utah underground detector. The data were analyzed in such a way that the angular dependence could be extracted without substantial sensitivity to the parameters of cosmic-ray phenomenology. The zenith angle distribution was flatter than expected on the basis of muon production via pion and kaon decay. An isotropic component (of unspecified origin) is required which rises to a maximum contribution of about 0.5 of the vertical intensity in the muon energy range 1 to 3 TeV and thereafter decreases. (auth)

12721 SURVEY ON THE TESTS OF ISOTROPY AND LOCALITY CONCEPTS OF SPACE AND TIME BY THE DISTRIBUTIONS OF THE COSMIC RAY MUON INTENSITY. Mizutani, K.; Mori, K. (Saitama Univ., Urawa, Japan). pp 1487-91 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Based on Tati's exponential form factor for the weak interaction vertex represented by a unit timelike vector, the momentum of decaying particle and the parameter of nonlocality, cosmic-ray muon intensities at various energy ranges were subjected to a survey for the special relativity breakdown. (auth)

12722 SEA WAVE AND TIDE RECORDING WITH COSMIC RAYS. Allkofer, O. C.; Simon, M. (Univ., Kiel). pp 1651-6 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Due to the nearly constant flux of incident cosmic-ray particles at sea level, measurements of tide gauge and of sea waves are feasible. A 4 m^2 scintillation detector was arranged in the North Sea with a mean water layer above the detector of 0.5 to 3 m. The time intervals of intensity read-out varied between 0.3 to 1 s. The tide movement could be measured by the average change of intensity with an accuracy of better than ±10 cm under consideration of several inconvenient effects. Using an autocorrelation method which considers the finite volume of measured data the frequency spectra of the sea waves could be resolved in a satisfactory manner. The heights of the waves could also be computed with an accuracy of about ±10 cm by a confidence band of 90%. (auth)

12723 DISTRIBUTION OF SCATTERED NEUTRONS RETURNING TO THE GROUND. Quang, T. T.; Fenton, K. B.; Fenton, A. G. (Univ. of Tasmania, Hobart, Australia). pp 1657-61 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

In a Monte Carlo calculation, neutrons of Maxwellian energy distribution are allowed to be projected isotropically into the air from a point on the ground. The energy and space distributions of those neutrons reentering the ground are found to have almost Maxwellian and exponential forms respectively. It is also found that the space distribution does not depend on the energy spectrum of the source neutrons. About 33% of these reflected neutrons are transmitted when incident on a slab of polyethylene 7.5 cm thick. The result also shows that half of the reflected neutrons strike the ground within 127 metres of the source. (auth)

12724 LUNAR NEUTRON FLUX REVISITED. Lingenfelter, R. E. (Univ. of California, Los Angeles); Canfield, E. H.; Hampel, V. E. Earth Planet. Sci. Lett.; 16: No. 3, 355-69(Nov 1972).

Cosmic ray-produced neutron equilibrium spectra are calculated for a variety of lunar surface compositions. From these spectra production rates of ^{80}Kr, ^{82}Kr, ^{114}Cd, ^{131}Xe, ^{150}Sm, ^{152}Sm, ^{152}Gd, ^{156}Gd, ^{158}Gd, and ^{187}Re due to neutron capture on ^{79}Br, ^{81}Br, ^{113}Cd, ^{130}Ba, ^{149}Sm, ^{151}Eu, ^{155}Gd, ^{157}Gd, and ^{186}W are determined and compared with measurements. (auth)

12725 SEARCH FOR EXTINCT NATURAL RADIOACTIVITY OF ^{205}Pb VIA THALLIUM-ISOTOPE ANOMALIES IN CHONDRITES AND LUNAR SOIL. Huey, J. M.; Kohman, T. P. (Carnegie-Mellon Univ., Pittsburgh). Earth Planet. Sci. Lett.; 16: No. 3, 401-412(Nov 1972).

Thallium and ^{204}Pb contents were determined by stable-isotope–dilution analysis in 16 chondrites, one achondrite, and Apollo 11 and 12 lunar fines. Meteoritic thallium contents vary over a large range, 0.02 to 100 ppB, corresponding to the fact that thallium is a highly fractionated volatile element. Lunar thallium contents are less than 5 ppB. The ^{205}Tl/^{203}Tl ratio was determined in most of the samples, with precision ranging from 0.03% to several percent

depending mainly on the amount of thallium present. No variations from the terrestrial ratio were observed. The chondritic isochron slope for ^{205}Pb (13.8-my half-life) is ≤0.00009 (99% confidence level), corresponding to an interval of at least 60 my and possibly exceeding 120 my between the termination of s-process nucleosynthesis and the lead-thallium fractionations. (auth)

12726 CLOUD CHAMBER STUDY OF HIGH TRANSVERSE MOMENTA IN COSMIC RAY AIR SHOWERS. Winterstein, D. F. Ann Arbor, MI; Univ. of Michigan (1972). 75p. University Microfilms Order No. 72-29,240.

Thesis.

The results of an experimental investigation into the possibility of using the large Leeds cloud chamber and its associated scintillator array to study multicore structure of extensive cosmic ray air showers (EAS) are presented. The detectors recorded the lateral density distribution of ionizing shower particles over an area of about 50 m^2; spatial resolution, however, was good only within the 2.88 m^2 horizontal area of the cloud chamber. The showers studied ranged in size from about 2×10^4 to 5×10^6 particles. The investigation was carried out by examining cloud chamber and scintillator data of 1750 EAS for the existence of subcores that represented transverse momenta considerably larger than the mean transverse momentum for pion production, at machine energies, of about 0.4 GeV/c. The conclusion was that, with sufficiently strict subcore selection criteria, the apparatus appeared usable for multicore studies. A subcore indicative of large transverse momentum (P_T) is believed to originate in the upper atmosphere in an energetic interaction which imparts high P_T to at least one energetic particle. The particle with high P_T generates an air shower whose axis at sea level is as far as several meters from the main shower axis. The subcore is detected as a particle density peak superposed on the main shower. The necessity of distinguishing subcores indicative of large P_T from other naturally occurring phenomena which can simulate such subcores requires that selection criteria be strict. Subcores of three events out of the 1750 satisfied the selection criteria. The calculated transverse momenta were 7, 8, and 46 GeV/c, with uncertainties of a factor of 2 or 3. From these results and from considerations of cloud chamber geometry and the shower trigger requirement it was estimated that the fraction of EAS with multicore structure indicative of large P_T was about 2%. (Diss. Abstr. Int., B)

12727 GENERAL STUDY OF THE EFFECT OF COLLISION PARAMETERS ON THE COSMIC-RAY FLUXES IN THE ATMOSPHERE. Jabs, A. (Univ., Trier-Kaiserlautern, Ger.). Nuovo Cim.; 12A: No. 3, 569-610(1 Dec 1972).

The vertical flux of nucleons, pions, and muons in the energy range 1 to 1000 GeV and at atmospheric altitudes of 0 to 48 km was calculated to an accuracy of better than 5%. Only the lateral extension of the cascades and the ionization loss of protons and pions were neglected. Many computer runs were started, in each run one of the parameters of the nucleon (or pion)–air-nucleus collision was varied. Among the parameters studied were the mean collision length, the mean inelasticity, the inelasticity distribution law, the secondaries' energy distribution (production spectrum), the multiplicity law, the fraction of produced kaons, the fraction of collisions with escaping excited nucleon, etc. By the definition of an 'efficiency index" it was possible to study the quantitative interrelation between these parameters and the particle fluxes at the various energies and atmospheric depths. This is demonstrated by numerous diagrams. Most effects are interpreted in terms of simple physical arguments. (auth)

12728 RESULTS FROM BALLOON MEASUREMENTS ON SECONDARY ELECTRONS AND PHOTONS. Scheel, Jochen; Roehrs, Heinrich (Christian-Albrecht-Univ., Kiel). Z. Phys.; 256: No. 3, 226-35(1972). (In German).

A scintillation counter telescope was flown in the upper atmosphere at 2.4 g/cm^2 from Bergen/Lüneburger Heide for the measurement of electrons and photons of the secondary cosmic radiation. The aim was to get the differential energy spectra of secondary photons in an energy range from 1 to 44 MeV and of secondary and return albedo electrons from 2 to 35 MeV for three different zenith angles (0°, 90°, and 180°). The photon spectrum was in good agreement with the results of other authors. It is shown, that the spectrum has large anisotropy with a maximum of intensity around the horizon. The main reason therefore is the atmospheric deepness in the different directions. In this energy range it was found that the bremsstrahlung of the return albedo electrons is the main reason for the photon flux and secondly the π^0-decay. The measured electron spectra didn't show any significant difference relative to the three zenith angles. These secondary electrons are produced isotropically in the upper atmosphere and they consist of a mixture of secondary and return albedo electrons. (auth)

Stars

Refer also to abstracts 12929 and 13165.

12729 (N-72-23889) ULTRAVIOLET FLUX ENVELOPES OF MAIN-SEQUENCE B STARS. Underhill, A. B. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr 1972. 48p. (NASA-TM-X-65873; X-670-72-102). NTIS.

Flux envelopes on an absolute energy scale from 1100 to 6000 A prepared from OAO-2 scans and from published ground-based material are presented for gamma Leporis, eta Ursae Majoris, gamma Ursae Majoris, alpha Lyrae, and alpha Canis Majoris. These, with already published flux envelopes for zeta Draconis and alpha Leonis (Underhill, 1972) are intercompared and compared with reference flux envelopes predicted by LTE theory from lightly line-blanketed model atmospheres. A considerable line blocking occurs at wavelengths shortward of 3000 A with respect to the theoretical continuous spectra. The line blocking may be as much as 50% at 1500 A and between 1500 A and 2500 A it is comparable to that which exists in the Sun between 3000 A and 4000 A. Although gamma Ursae Majoris, alpha Lyrae, and alpha Canis Majoris have very similar visible spectra when viewed at low resolution, their ultraviolet spectra are significantly different, in particular alpha Lyrae shows an ultraviolet excess. (auth)

12730 STELLAR EVOLUTION. Chiu, H. Y.; Muriel, A. (eds.). Cambridge, MA; Massachusetts Institute of Technology Press (1972). 822p. $15.00. (NP-19601).

This book is based on 22 lectures given at the Third Summer Institute for Astronomy and Astrophysics held at Stony Brook from June 18 to July 16, 1969. (W.D.M.)

12731 INTERACTION OF STARS WITH LOCAL DUST FORMATIONS. Arshinova, V. A.; Dagaev, M. M.; Radzievskii, V. V. (Gorky Teacher's Coll., USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 426-32(1972).

Translated from Astron. Zh.; 49: No. 3, 524-32(1972).

An analysis was made of the redistribution of the density of dust material in initially homogeneous cosmic dust clouds encountering stars for which the repulsive force exceeds the gravitational attraction. The density was determined as a function of spherical coordinates separately for particles approaching the star and particles already reflected from the limiting isodensity curve. A new method for obtaining Kepler's equation is suggested, and a derivation is given for motion along the outer branch of a hyperbolic orbit. The results were used to establish the shape of the isochrones for particles that belonged to a spherical or plane front of the cloud at a large distance from the star. A deformation of the edge of the cloud approaching the star might be one factor responsible for the parabolic dents observed in the boundaries of certain nebulae. The problem is solved in the celestial-mechanics approximation, but the contribution of interparticle collisions and gas viscosity is also considered. (auth)

12732 STRATIFICATION OF THE EMISSION IN THE ENVELOPE OF THE ECLIPSING-BINARY WOLF-RAYET STAR V444 CYGNI. Cherepashchuk, A. M.; Goncharskii, A. V.; Yagola, A. G. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 433-41(1972).

Translated from Astron. Zh.; 49: No. 3, 533-43(1972).

The brightness distribution over the disk of the WR component was derived from the intensity curves of nine emission features (ionization potential χ = 47.20 to 97.43 eV) observed by Kuhi during eclipse of the WR star by the O6 V companion. A regularization method developed by Tikhonov was applied. For ions with χ > 60 eV the WR envelope, perturbed by proximity effects of the O6 V companion, showed a significant concentration of emission toward the WR core. In the WR envelope, perturbed by proximity effects, direct stratification of ions by ionization state was found, on the average, for χ > 60 eV: The characteristic size of the ionization zone diminished as χ rises. The importance of a detailed study of the emission features at phases outside eclipse in order to ascertain the role of proximity effects in the system is emphasized. (auth)

12733 SOLUTIONS OF THE LIGHT CURVES OF ECLIPSING BINARIES BY THE GENERALIZED METHOD OF LEAST SQUARES. Tabachnik, V. M. (Ushinskii Teachers' Coll., Odessa). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 442-9(1972).

Translated from Astron. Zh.; 49: No. 3, 544-54(1972).

New equations are derived for determining the elements of eclipsing binary stars by minimizing the sum of the squares of the weighted distances of an observed point on the light curve from the regression line. The approximating line passes through the weighted center of gravity of this curve, which is displaced

toward the time of inner contact of the stars; there is a simple physical interpretation of this fact. A process for estimating the errors in the computed parameters is described. (auth)

12734 INFLUENCE OF A RANDOM MAGNETIC FIELD ON THE PROPERTIES OF STELLAR ABSORPTION LINES. Dolginov, A. Z.; Pavlov, G. G. (Physical-Technical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 450-9(1972).

Translated from Astron. Zh.; 49: No. 3, 555-67(1972).

An analysis was made of the influence of a random, statistically homogeneous magnetic field on the profiles and polarization characteristics of absorption lines when light passes through an optically thin layer. Equations were obtained relating the Stokes parameters of the transmitted and incident radiation for a random field component of two types: a) a component of definite direction but random intensity; b) a statistically isotropic random component. In both cases the σ components of the Zeeman triplet are broadened. A random field of type a does not affect the positions of the maxima of the σ components, and their profiles remain symmetric. A field of type b will induce asymmetry in the σ components and increase the separation between them. Only if a type b random component is present can a line be split even if the mean field is zero, but it will remain unpolarized. Even a slight addition of a type b field to a regular longitudinal field will generate an appreciable unpolarized π component. This effect might account for the central component of the Zeeman triplet observed in the umbrae of sunspots located at the center of the disk. The various effects should be detectable experimentally and would permit the random field component to be measured if it should be as large as a few hundred gauss. (auth)

12735 SELF-SIMILAR SOLUTION FOR NONSTEADY HYDRODYNAMIC ACCRETION. Bisnovatyi-Kogan, G. S.; Zel'dovich, Ya. B.; Nadezhin, D. K. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 393-7(1972).

Translated from Astron. Zh.; 49: No. 3, 483-8(1972).

A self-similar solution is obtained describing the infall of gas in a constant, uniform gravitational field onto a hard wall. The solution may be used to represent the initial phase of accretion of matter by the neutron-star remnant of a supernova explosion. The conditions for applicability of the solution are discussed. (auth)

12736 NUMERICAL EXPERIMENT IN THE ACCRETION PROBLEM. Aleshin, V. I.; Kaplan, S. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 398-401(1972).

Translated from Astron. Zh.; 49: No. 3, 489-93(1972).

By means of a numerical experiment one can calculate the accretion of gas in a protocluster of protostars, with explicit allowance for the way that the growth in mass depends on the varying velocity of the protostars. (auth)

12737 SPECTROSCOPIC STUDY OF THE NEBULA NGC 7635 AND THE STAR BD +60°2522. Doroshenko, V. T. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 402-9(1972).

Translated from Astron. Zh.; 49: No. 3, 494-503(1972).

A quantitative spectral classification of the star BD + 60°2522 was made and its absolute spectral energy distribution [erg $\cdot$ cm^{-2} $\cdot$ sec^{-1} $\cdot$ Å^{-1}] was derived. The observed anomalous energy distribution can be represented if the star is a spectroscopic binary with type O5 and F5 Ib components. The physical conditions in NGC 7635 were investigated. The flux in the Hβ line [erg $\cdot$ cm^{-2} $\cdot$ sec^{-1}] was evaluated for several regions in the nebula. The mean electron density $n_e = 400$ cm^{-3}; the electron temperature $T_e = 9600$°K. The mass of the nebula is $\approx 4.5 M_\odot$. (auth)

12738 BRIGHT RED GIANTS IN THE GLOBULAR CLUSTERS M3, M5, AND M13. Kadla, Z. I.; Spasova, N. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 410-17(1972).

Translated from Astron. Zh.; 49: No. 3, 504-13(1972).

All the members of M3, M5, and M13 belonging to the brightest part of the red-giant branch (in the range $\Delta V = V - V_t \approx 1.30$m, where V_t is the mean magnitude of the five brightest cluster members) were identified from proper motions and V photometry. About 60% of the bright red giants are at distances $r < 1.5'$ from the cluster center. The distribution of these stars along the giant branches of the three clusters as well as M92 showed no statistically significant differences. A comparison of the distribution of RR Lyrae variables and bright giants with angular distance from the center of M3 and M5 indicated that the two groups of stars belong to the same parent population in the zones $r > 2.0'$ for M3 and $r > 0.5'$ for M5. Closer to the center the number of variables is too small, either because of mass loss or incomplete detection of RR Lyrae stars. A relation was found between the number of RR Lyrae variables and the number of giants brighter than $V_{RR} - \Delta V_{RR\text{-}G}$, where $\Delta V_{RR\text{-}G} = 1.90$, 2.10, and 2.30m. (auth)

12739 LAW OF ROTATION OF POLYTROPIC CONFIGURATIONS. Blinnikov, S. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 534-6(1972).

Translated from Astron. Zh.; 49: No. 3, 654-8(1972).

The possibility of differential rotation of polytropic stellar models is shown as an example of the exact solution of the structure equations for an n = 1 polytrope. It is shown that the conclusion of Porfir'ev (1959), which contains the opposite result, is not true. (auth)

12740 GLOBULAR CLUSTER M92. Mel'nikov, O. A.; Kadla, Z. I. (Main Astronomical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 540-2(1972).

Translated from Astron. Zh.; 49: No. 3, 661-3(1972).

Data are given which show that the giants having enhanced CN and CH bands and strong metallic lines, assumed to be members of the globular cluster M92, are actually field stars. (auth)

12741 COMPLETE SPECTRUM OF PULSATION FREQUENCIES FOR A POLYTROPIC ATMOSPHERE. Oganesyan, R. S. (Erevan State Univ.). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 552-3(1972).

Translated from Astron. Zh.; 49: No. 3, 672-4(1972).

Radially symmetric oscillations of a planetary-type polytropic atmosphere are investigated by a small-perturbation method. The linearized equation for small oscillations, allowing for compressibility and a nonuniform density distribution, is solved exactly. The complete frequency spectrum is derived. (auth)

12742 DIMENSIONAL ANALYSIS AND GROUP THEORY IN ASTROPHYSICS. Kurth, R. New York; Pergamon Press, Inc. (1972). 245p. $22.50.

In order to understand the applications of dimensional analysis, it is first necessary to understand its foundations and principles. These are clarified and its applications to the solution of astrophysical problems are demonstrated. The importance of group theory in the reduction of ordinary differential equations is discussed, and its particular application to astrophysics in the reduction of the differential equations associated with the theory of stellar structure is explicitly demonstrated. (W.D.M.)

12743 GINZBURG-LANDAU EQUATION FOR $^3P_2$ PAIRING. SUPERFLUIDITY IN NEUTRON STARS. Fujita, Toshimitsu; Tsuneto, Toshihiko (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 766-82(Sep 1972).

Superfluid properties of a neutral fermion system with pairing in a nonzero angular momentum state, in particular, with $^3P_2$ pairing expected in neutron stars, were studied. The gap equation and the equation of the Ginzburg-Landau (G-L) type were derived for general pairing. The case of $^3P_2$ pairing was considered and the G-L equation for the five component order parameter in the form of a nonlinear field equation for a spin 2 field is presented. The expressions for the free energy, the current density, and the angular momentum density were found in terms of the order parameter. With the help of the G-L equation some features of vortex states are discussed. (auth)

12744 RADIO BEHAVIOR OF β PERSEI. Hjellming, R. M.; Webster, E.; Balick, B. (National Radio Observatory, Green Bank, WV). Astrophys. J.; 178: No. 3, L139-44(14 Dec 1972).

Radio observations of β Per at 2695 and 8085 MHz during April - July 1972 are summarized, and the details on several unusual events are given. The implications of the data, which show dominant thermal behavior with very rare nonthermal events, are related to a model of a variable thermal source energized by shock waves and/or suprathermal particles ejected when a star adjusts its structure discontinuously by means of "starquakes." (auth)

12745 UBV AND Hβ PHOTOMETRY OF THE GALACTIC CLUSTER NGC 2343. Claria, J. J. (Univ. Nacional, Cordoba, Argentina). Astron. J.; 77: No. 10, 868-74(Dec 1972).

The results are presented of a photoelectric study of the galactic cluster NGC 2343. UBV observations of 55 stars in the vicinity of the cluster confirm a minimum membership of 32 stars including HD 54387, a very possible giant member. Photoelectric measurements of the Hβ line intensity of 16 early-type stars are given. A uniform (B-V) color excess of 0.20m was found for the cluster. A distance of 960 pc and an age of about 106 million yr were also derived. (auth)

12746 LUMINOSITY FUNCTION AND DENSITY DISTRIBUTION OF DISK POPULATION STARS. Weistrop, Donna (Carnegie Institution of Washington, DC). Astron. J.; 77: No. 10, 849-62(Dec 1972).

The density distribution and luminosity function of the disk population were investigated, using star counts as a function of V and B-V for several thousand stars near the North Galactic Pole. Having estimated the contributions to the counts due to Population II stars and disk giants and subgiants, the remaining

stars were assumed to constitute a pure disk-dwarf population. Density distributions for stars in successive $(B-V)_0$ intervals were calculated and combined to form a composite disk density distribution. The agreement with Oort's K-giant distribution was satisfactory. There was evidence that dwarfs redder than $(B-V)_0 = 1.4$ are concentrated in a narrow layer in the plane, similar to the interstellar gas. Determination of the luminosity function for the reddest disk dwarfs indicated that these stars are five to ten times as numerous as was previously thought, thus accounting for a significant fraction of the missing mass in the solar neighborhood. The luminosity function was extrapolated to estimate the contribution to the missing mass of main sequence stars fainter than those considered in the analysis. (auth)

12747 FOUR COLOR AND Hβ PHOTOMETRY FOR OPEN CLUSTERS. VIII. IC 4665. Crawford, D. L.; Barnes, J. V. (Kitt Peak National Observatory, Tucson, AZ). Astron. J.; 77: No. 10, 862-8(Dec 1972).

Photoelectric uvbyβ photometry of 45 B-, A-, and F-type stars contained in or near the cluster IC 4665 were obtained at the Kitt Peak National Observatory between 1964 and 1972. Thirty-two of these stars appear to be cluster members. The average color excess, due to interstellar reddening, is E(b−y) = 0.14m and is slightly variable over the field. The true distance modulus was found to be $V_0 - M_V = 7.5$m by several different methods. Systematic effects in the photometry due to rotational velocity differences from star to star do not appear to be present in the B-type stars, but are evident in the A-type stars. The cluster appears to be slightly younger than the Pleiades. (auth)

12748 INFRARED MEASUREMENTS OF R CORONAE BOREALIS THROUGH ITS 1972 MARCH–JUNE MINIMUM. Forrest, W. J. (Univ. of California, San Diego); Gillett, F. C.; Stein, W. A. Astrophys. J.; 178: No. 3, L129-32(15 Dec 1972).

Infrared (3.5 to 11 μ) observations of R CrB through the recent March–June 1972 visual minimum are presented, and an interpretation in terms of dust clouds surrounding the star is suggested. (auth)

12749 RED GIANTS IN NGC 6752. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J.; 178: No. 3, L109-10(15 Dec 1972).

The previously published observations of red giants in this cluster refer, for the fainter stars, mainly to asymptotic-branch stars. New data have been obtained for stars on the subgiant sequence. (auth)

12750 OPTICAL OBSERVATIONS OF HZ HERCULIS. Groth, E. J.; Nelson, M. R. (Princeton Univ., NJ). Astrophys. J.; 178: No. 3, L111-14(15 Dec 1972).

Optical observations of HZ Herculis show no evidence of pulsation (to better than 0.1%) and no evidence of nonperiodic modulation. (auth)

12751 MINIMUM MASS OF A NEUTRON STAR. Leung, Y. C. (Southeastern Massachusetts Univ., North Dartmouth); Wang, C. G. Nature (London) Phys. Sci.; 240: No. 102, 132-3(11 Dec 1972).

It is stated that the mass of a star is completely determined by its equation of state with appropriate boundary conditions. For neutron stars, because of their high density, the equation of state can usually be approximated by that of cold degenerate matter, since the stellar thermal energy is small compared with the Fermi kinetic energy of the matter. Investigation of the minimum mass of a neutron star requires consideration of the equation of state only at subnuclear densities. The question of implosion in the formation of a neutron star also plays a role in the equation of state; fortunately at near nuclear densities the equation of state with pure neutrons is not very different from neutrons clustered with heavy nuclei and the two equations may be considered as upper and lower limits. Another factor concerning the minimum mass of a stable neutron star is the average binding energy per nucleon; neutron matter is not bound, but is held together by tremendous gravitational pull. On the surface of a neutron star the matter is probably composed of solid iron, with a gravitational potential of about 5 MeV per nucleon; this surface is very tightly bound, and is the result of the equation of state used to construct the star. The stable minimum mass with a core of pure neutron gas is 0.67 $M_\odot$, and with a core clustered with heavy nuclei is 0.093 $M_\odot$. The real minimum mass is probably somewhere between these two numbers. (UK)

12752 FAMILIES OF ISOENERGETIC ESCAPES AND EJECTIONS IN THE PROBLEM OF THREE BODIES. Szebehely, V. (Univ. of Texas, Austin). Astron. Astrophys.; 22: No. 2, 171-7 (Jan 1973).

A triple stellar system with mass ratios 4:1:1 is subjected to isoenergetic variations and its dynamical behavior is found. The initial positions of the two small masses are fixed and the third body is placed so as to keep the potential energy of the system constant. All the initial velocities being zero, the equipotential placements of the third body result in isoenergetic variations of the initial conditions. The behavior of this dynamical system displays a series of continuous transitions between escapes, ejections, and interplays. The dynamical characteristics of the ejected or escaping body and of the binary left behind are presented and the escape or ejection parameters are evaluated. The systematic and continuously changing behavior of the system with variations of the initial conditions shows the existence and boundaries of a series of "islands," the nature and properties of which have been discussed by Agekian (1967) and Szebehely (1972-a, b). (auth)

12753 CYCLIC VARIATIONS OF THE Be STAR β^1 MONOCEROTIS. Cowley, Anne; Gugula, Elaine (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 22: No. 2, 203-8(Jan 1973).

Since the mid-1920's the Be star β^1 Mon has undergone regular changes in the shell velocity, intensity ratio of the double hydrogen emission components (V/R), and reappearance of a strong absorption shell seen primarily in the hydrogen and Fe II lines. A "period" of 12.5 years persisted for three and a half cycles. During the last few years these variations have ceased, and the spectrum appears much as it did between 1905 and 1925 when there were also no significant spectral variations. A qualitative model is presented. (auth)

12754 PHOTOMETRIC INVESTIGATIONS OF MAGNETIC STARS. Stift, M. M. (Univ., Vienna). Astron. Astrophys.; 22: No. 2, 209-15(Jan 1973).

UBV photoelectric observations of four peculiar stars are considered: HD 358, HD 32633, HD 215441, and HD 25823. The analysis yields respective periods for the first three stars of 0.9636 days, 6.431 days, and 9.4866 days; no period can be found for the star HD 25823. For HD 215441 a phase shift is detected between the light curves in different colors and indications are found for secular variations of period length. For an explanation of these phenomena a hypothesis is proposed which is compatible with the Oblique Rotator Theory. Assuming the Oblique Rotator Model, the spatial distribution of the rotational axes of the magnetic stars is determined. For some stars with well known magnetic variations it can be shown by detailed calculations that the magnetic axes always lie near or in the equatorial plane and that Landstreet's Oblique Rotator Model is not applicable for all these stars. Moreover, there seems to be no correlation between surface brightness and magnetic field strength. (auth)

12755 APPLICATION OF THE THEORY OF RADIATIVE TRANSFER TO STELLAR IMAGES IN THE PHOTOGRAPHIC EMULSION. Seboldt, W. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys.; 22: No. 2, 217-27(Jan 1973). (In German).

The theory of radiative transfer is used to derive a theoretical relationship between the brightness of a star and its effective radius in the developed photographic emulsion. (W.D.M.)

12756 SPECTRAL CLASSIFICATION OF THE β CEPHEI STARS AND THEIR LOCATION IN THE THEORETICAL HERTZSPRUNG–RUSSELL DIAGRAM. Lesh, J. R. (Univ. of Colorado, Boulder); Aizenman, M. L. Astron. Astrophys.; 22: No. 2, 229-37 (Jan 1973).

Spectral types on the MK system are presented for 17 bright β Cephei variables, 7 bright suspected variables, and 23 fainter suspected variables. Classification of the fainter stars is based on new plates obtained at the Haute-Provence Observatory. The bright variables are located in the observational HR diagram by means of the photometric parameters Q and β, and their position relative to normal B stars is discussed. A transformation to the $(\log T_{eff}, M_{bol})$ plane enables one to compare the positions of both normal stars and β Cephei variables with evolutionary tracks. It is found that the variables occupy a very restricted region in the observational HR diagram, but that this region is also populated by many normal B stars. In the theoretical HR diagram, this "instability strip" is shown to coincide with the region traversed three times by a star in the course of its post-main-sequence evolution: once in the core hydrogen-burning phase, once in the secondary contraction phase, and once in the shell hydrogen-burning phase. A natural hypothesis is that the normal B stars in this region are in the core hydrogen-burning phase, while the β Cephei variables are in one of the two later stages of evolution. (auth)

12757 DETERMINATION OF MINIMUM TIMES OF LIGHT CURVES. Breinhorst, R. A.; Pfleiderer, J.; Reinhardt, M. (Univ., Bonn).; Karimie, M. T. Astron. Astrophys.; 22: No. 2, 239-45(Jan 1973).

The method of Kwee and van Woerden, frequently used to determine minimum epochs of eclipsing binary stars, is discussed

regarding its application to asymmetric light curves. Expressions are derived, in second-order approximation, for the difference between Kwee–van Woerden and true minimum epoch as well as the Kwee–van Woerden mean error of the minimum, as functions of the asymmetry. A least-squares fit by a third-degree polynomial is proposed as an alternative method of minimum determination. Both methods are applied to artificial and observed light curves. Several new minimum epochs of i Boo and VW Cep are evaluated. (auth)

12758 SHORT-PERIOD VARIABILITY OF B, A, AND F STARS. VI. NEW DELTA SCUTI STARS IN SELECTED REGIONS. Breger, Michel (Univ. of Texas, Austin). Astron. Astrophys.; 22: No. 2, 247-9(Jan 1973).

Twelve more short-period Delta Scuti variables have been discovered, bringing the total number to about 70. The new variables are situated in the field as well as in the Praesepe and Hyades clusters. Visual amplitudes are as small as 0.01 mag. The derived periods are typical for the positions of the stars in the color–magnitude diagram. (auth)

12759 SPECTRAL VARIATIONS OF 53 CAM(AX,CAM). Faraggiana, R. (Astronomical Observatory, Trieste, Italy). Astron. Astrophys.; 22: No. 2, 265-72(Jan 1973).

A study of the variability of the radial velocities and spectral line intensities of 53 Cam was made on spectra of 9.7 Å/mm and 12.4 Å/mm dispersion taken during the period 1967–1970 at the Haute Provence Observatory. The radial velocities appear to fit at least two different periods: (a) a shorter one whose length is uncertain between two values—the 1.14229d (suggested by Rakos) and the ~8d suggested by several other authors; (b) a period much longer (on the order of several years) still undetermined but suggesting the possibility that 53 Cam is a binary. Another characteristic of the radial velocities of this star is the peculiar behavior of the Mn I lines that give a more negative RV by at least 10 km s^{-1} with respect to other elements. The line intensities show a variability which follows (in general out of phase from element to element) the 8d periods. The Balmer discontinuity derived from the photometric index c_1 appears to be lower than expected from the spectral type. (auth)

12760 REVISED CHEMICAL ABUNDANCES OF FOUR POPULATION-II A-TYPE STARS. Kodaira, Keiichi (Univ., Heidelberg). Astron. Astrophys.; 22: No. 2, 273-9(Jan 1973).

The previous spectral analyses of the population-II A-type stars BD + 39° 4926 (Kodaira et al., 1970), HD 161817 (Kodaira, 1964), and HD 86986 and HD 109995 (Kodaira et al., 1969) are critically examined to yield revised chemical abundances, in accordance with new gf-values for Mg, Si, Fe, and Ni. The atmospheric model for BD + 39° 4926 has to be modified according to $\Delta\theta_{eff} \simeq +0.05$ and $\Delta \log g \simeq -0.7$, while the models for the other three stars remain valid. For the abundance determination, the corrections of gf-values and physical parameters are taken into account by a differential method. The revised chemical abundances are presented. The bearing of the revision on the theory of the element synthesis is discussed. (auth)

12761 ATMOSPHERIC ABUNDANCES IN THE CARBON STAR HD 156074. Greene, T. F.; Perry, James; Snow, T. P.; Wallerstein, George (Univ. of Washington, Seattle). Astron. Astrophys.; 22: No. 2, 293-8(Jan 1973).

Atomic and molecular lines were studied from 6.7 Å/mm coudé spectrograms of HD 156074. From the colors and spectra an effective temperature of 4750°K was derived with a possible uncertainty of 250°K. The ratio of iron to hydrogen was normal and the ratios of other elements, from sodium to neodymium, to iron were found to deviate from the solar ratio by no more than a factor of three, which is not considered significant. The CNO abundances were abnormal with ^{13}C enhanced, ^{14}N enhanced, and oxygen deficient as presented. The abundances, combined with the fact that the heavy s-process elements and lithium are not enhanced are very difficult to explain by the CNO bi-cycle. The ratio of $^{12}C/^{13}C$ indicated that CNO equilibria have been reached but solutions with a sufficiently high ^{14}N abundance yield an excess of CNO/H which is inconsistent with the normal ratio of metals to hydrogen. (auth)

12762 UPPER LIMITS TO THE 21 CM CONTINUUM RADIATION FROM TWO MAGNETIC WHITE DWARFS. Ekers, R. D. (Kapteyn Astronomical Inst., Groningen, Netherlands). Astron. Astrophys.; 22: No. 2, 309-10(Jan 1973).

Observations with the Westerbork Synthesis Radio Telescope place a limit of 2×10^{-29} Wm^{-2} Hz^{-1} on the 21 cm continuum radio emission from the magnetic white dwarfs Grw + 70° 8247 and G 195–19. A list of the field radio sources found in these observations is included. (auth)

12763 PHOTOGRAPHIC OBSERVATIONS OF THE SUPERNOVA 1971 in NGC 5055. Duerbeck, H. (Univ., Bonn). Astron. Astrophys.; 22: No. 2, 317-18(Jan 1973).

Photographic magnitudes of the supernova 1971 in NGC 5055 are given. The light curve is discussed briefly. (auth)

12764 ACCRETION VORTICES AND X-RAY SOURCES. Henriksen, R. N.; Chia, T. T. (Queen's Univ., Kingston, Ont.). Nature (London) Phys. Sci.; 240: No. 102, 133-5(11 Dec 1972).

It is stated that accretion of interstellar material has been invoked in connection with magnetic (Aρ) stars and with x-ray stars, but little work has been carried out on the basic mechanism. The present authors studied accretion onto a rotating magnetized star, and found some unexpected results; their implications for x-ray sources are here outlined. The principle result is an exact expression for the accretion rate per unit solid angle along a sheared field line onto a rotating nontranslating (sub-Alfvenic) magnetic monopole. The result also applies rigorously along a given field line in any axially symmetric geometry. It is emphasized that the result is valid only near a magnetic axis. As material approaches the star it tends to be funneled down the magnetic axis; the throat of the funnel, is located at the vortex radius, defined as the radius at which the sum of the radial magnetic force and the centrifugal force vanishes. Inside the vortex radius the accretion flow is rapidly accelerated by a combustion of magnetic tension and gravity. (UK)

12765 STELLAR COMPOSITIONS FROM NARROW-BAND PHOTOMETRY. 4. CALCIUM ABUNDANCES IN G AND K GIANTS. Rego, M. E.; Williams, P. M.; Peat, D. W. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 160: No. 2, 129-37(1972).

Narrow-band calcium photometric indices have been measured with the Cambridge spectrometer for 147 G- and K-type giant stars. Calcium abundances have been derived from the indices using model atmospheres The variation of calcium abundance from the most metal-poor to the metal-rich stars is less than that of sodium or iron. (auth)

12766 FOUR-COLOUR AND Hβ PHOTOMETRY OF SOME BRIGHT SOUTHERN STARS. Stokes, N. R. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 160: No. 2, 155-68(1972).

Observations of 511 bright southern B, A, F, and G stars in the four-colour (y, b, v, u) and Hβ systems are reported. (auth)

12767 NATURE OF THE SAGITTARIUS OBJECT IRC-20385. Wing, R. F. (Perkins Observatory, Delaware, OH); Warner, J. W.; Smith, M. G. Astrophys. J.; 179: No. 1, 135-45(1 Jan 1973).

The infrared source IRC – 20385 consists of the extended object Terzan 5 and a nearby star of type M8. The observations of Terzan 5, including new narrow-band photometry, image-tube spectroscopy, and direct photography, are consistent with the hypothesis that it is a normal globular cluster suffering 9.4 mag visual absorption. This hypothesis leads to a photometric distance of 8 kpc, which is consistent with independent arguments that it must lie in front of the nuclear bulge of our Galaxy. (auth)

12768 SPECTROSCOPIC STUDIES OF O-TYPE STARS. II. COMPARISON WITH NON-LTE MODELS. Conti, P. S. (Univ. of Colorado, Boulder). Astrophys. J.; 179: No. 1, 161-79(1 Jan 1973).

Equivalent widths of strong He I and He II lines and Hγ in a large sample of O stars were compared with predictions from the plane-parallel non-LTE models of Auer and Mihalas. There was very good agreement indicating the essential correctness of their models. However, for many stars there was a dramatic difference between the predictions and the observations of λ4686 He II. This was almost certainly the result of neglect of extended-envelope and dynamical effects in these stars. This line is a useful spectroscopic tool to identify stars in which plane-parallel atmospheres are not completely appropriate. The runs of equivalent widths of representative lines of C III, N III, O III, and Si IV are also presented for many O stars. There is a positive gravity (luminosity) effect for the latter three ions, but model predictions have not yet been made. The presence of the "unidentified" emission lines at λλ4486, 4504 correlates well with λ4686 He II tending to emission, and suggests that these lines are formed only in extended envelopes. (auth)

12769 SPECTROSCOPIC STUDIES OF O-TYPE STARS. III. THE EFFECTIVE-TEMPERATURE SCALE. Conti, P. S. (Univ. of Colorado, Boulder). Astrophys. J.; 179: No. 1, 181-8(1 Jan 1973).

An effective-temperature scale for O-type stars is presented, based upon a comparison of measures of λ4471 He I/λ4541 He II and predictions from the non-LTE models of Auer and Mihalas.

There is reasonably good agreement between this scale and the effective temperatures inferred from O stars in H II regions by the Zanstra method. The problems associated with the low effective temperature derived for ζ Pup by interferometric methods are also discussed. (auth)

12770 OPTICALLY THIN STELLAR WINDS IN EARLY-TYPE STARS. Cassinelli, J. P.; Castor, J. I. (Univ. of Colorado, Boulder). Astrophys. J.; 179: No. 1, 189-207(1 Jan 1973).

The role of the radiation field in the heating, cooling, and transfer of momentum to expanding atmospheres of hot stars is examined. The general equations for radial, steady-state flow are presented, and the conditions for the existence of a transonic flow are discussed. Numerical solutions are carried out for a case in which the run of mean intensity is assumed to be that of freely streaming radiation. Limits are deduced for the ratio of the velocity of escape to the thermal speed at the sonic point. True absorptive opacity is found to be essential for the transition to supersonic flow. If this opacity is sufficiently large, the temperature stratification deviates negligibly from that in radiative equilibrium. The outward force due to radiation pressure must be only slightly less than the inward force of gravity in order to obtain sonic points reasonably close to the star. Nevertheless, ignoring the probable disruption by the interstellar medium, all stars should have stellar winds and the rate of mass loss may be as large as order $(L/v_\infty c)$. A two-point boundary-value technique is presented which ensures that the atmosphere approaches the usual static behavior at the base and becomes transonic at a larger radius. (auth)

12771 ANALYSES OF LIGHT-ION SPECTRA IN STELLAR ATMOSPHERES. II. THE CALCIUM II K-LINE IN B STARS. Mihalas, Dimitri (High Altitude Observatory, Boulder, CO). Astrophys. J.; 179: No. 1, 209-20(1 Jan 1973).

A calculation of the Ca II K-line strength in the middle B stars was performed by means of a self-consistent solution of the equations of transfer and steady-state statistical equilibrium. The multilevel model ion, with many explicitly computed bound–bound transitions, was treated as part of a multi-ion system (Ca II, Ca III, Ca IV). Results are given for two abundances and microturbulent velocities, and are used to assess systematic errors in LTE diagnostics of these parameters. Near the main sequence for the middle B stars the results showed that departures from LTE have a negligibly important effect on the K-line equivalent width, but at higher temperature and lower gravities these departures become ever more important, and in the extreme cases can result in errors in the abundance deduced from LTE of a factor of five, or spurious microturbulent velocities of up to 3 km s^{-1}. These effects are less spectacular than those found earlier by the author for Mg II, but insofar as the K-line is at all typical of a line of comparable strength in these stars, the results may have farther-reaching implications for errors in the usual LTE diagnostics. A discussion of the K-line strengths in ι Her and γ Peg indicates that they are compatible with a Ca abundance in these stars equal to the solar abundance. (auth)

12772 SPECTROSCOPICALLY DISTINGUISHED CLASS OF Be STARS. Schild, R. (Smithsonian Astrophysical Observatory, Cambridge, MA). Astrophys. J.; 179: No. 1, 221-30(1 Jan 1973).

The pole-on hypothesis to account for a group of Be stars having sharp He I absorption lines and broad hydrogen absorption wings is critically examined. On the basis that the stars are not typical Be stars, the hypothesis is rejected and the true pole-on stars are identified. A relation between emission- and absorption-line radial velocities is established, and a model of differential rotation to explain the different line widths is discussed with respect to the observations. (auth)

12773 ULTRAVIOLET STELLAR FLUXES. IV. IMPORTANCE OF BOUND-FREE ABSORPTION OF S I IN B TO K STARS. Tarafdar, S. P.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Astrophys. J.; 179: No. 1, 231-4(1 Jan 1973).

The bound-free absorption of S I has been found to be an important source of opacity in the spectral region $\lambda\lambda 1000-1197$ Å in stars as early as B5. (auth)

12774 LINEAR NONADIABATIC ANALYSIS OF RADIAL OSCILLATIONS IN MODELS FOR BETA CEPHEI STARS. Davey, W. R. (Univ. of Waterloo, Ont.). Astrophys. J.; 179: No. 1, 235-40(1 Jan 1973).

A linearized, fully nonadiabatic analysis was used to examine the pulsational stability toward radial oscillations of stellar evolutionary models passing through that portion of the H–R diagram occupied by β Cephei stars. Equilibrium models in three distinct phases of evolution were constructed: post–main-sequence models of 10 and 15 $M_\odot$, pre–main-sequence models of 15 $M_\odot$, and highly evolved models of 2.5 $M_\odot$. All were found to be stable in the fundamental mode of oscillation and in several of the lowest few overtones. An extra thermal-imbalance term caused by the lack of thermal equilibrium in the static models was found to be completely negligible for these models. (auth)

12775 LEAST-SQUARES DETERMINATION OF MASS RATIOS OF SPECTROSCOPIC BINARIES. Irwin, J. B. (Louisiana State Univ. Observatory, Baton Rouge). Astrophys. J.; 179: No. 1, 241-7(1 Jan 1973).

The method of Wilson, as applied to double-lined spectroscopic binaries, was modified and extended so that definitive determinations of mass ratios and systemic velocities could be made; appropriate weighting of individual velocities is possible. The new method is a differential one, and these two elements can be obtained separately from the solution for the other orbital elements in a double-lined spectroscopic binary. Applications to one visual binary and to six eclipsing binaries are given. Evidence is presented suggesting that the probable error of the quantity $K_1 + K_2$ is overestimated when derived from the residuals of individual radial velocities. (auth)

12776 ADVANCED EVOLUTION OF MASSIVE STARS. III. HYDROSTATIC CARBON-BURNING NUCLEOSYNTHESIS AND ENERGY GENERATION. Arnett, W. D. (Univ. of Texas, Austin). Astrophys. J.; 179: No. 1, 249-56(1 Jan 1973).

Carbon-burning nucleosynthesis and energy generation in hydrostatic stars is considered, using a realistic reaction network. Useful approximations are presented and compared with the numerical results. It is found that the hydrostatic nucleosynthesis resembles that at a suitably chosen, constant temperature, and that the "no-sodium approximation" works well for massive stars ($M \gtrsim 15\ M_\odot$). (auth)

12777 MAGNETIC CONFIGURATION IN THE NEIGHBORHOOD OF A COLLAPSED STAR. Cohen, R. H.; Coppi, B.; Treves, A. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 179: No. 1, 269-75(1 Jan 1973).

It is shown that the magnetic configuration in the neighborhood of a collapsed star with parameters appropriate for models of x-ray stars or pulsars is nearly force-free, with $(\nabla \times B)/B$ nonconstant. In the case where the magnetic axis coincides with the rotation axis, a differential equation for the magnetic surfaces is derived. A proper double-expansion technique is used to obtain a significant asymptotic solution of this equation and to derive explicit expressions for the relevant magnetic-field components. (auth)

12778 DETERMINATION OF PROPERTIES OF COLD STARS IN GENERAL RELATIVITY BY A VARIATIONAL METHOD. Nauenberg, Michael (Univ. of California, Santa Cruz); Chapline, G. Jr. Astrophys. J.; 179: No. 1, 277-87(1 Jan 1973).

Approximate analytic formulae are obtained for the mass, the number of baryons, and the radius of a cold star by applying the energy variational principle in general relativity to a uniform density sphere of baryons. Conditions for equilibrium and for stability are expressed by transcendental equations which generalize familiar results of Newtonian theory. These formulae allow one to understand readily how various assumptions concerning the equation of state affect the properties of a neutron star. Comparison with some numerical calculations in the literature based on the differential equation for hydrostatic equilibrium in general relativity indicates that the analytic approximations are in reasonable quantitative agreement with exact results. By making use of the condition that the speed of sound is less than the speed of light, and of properties of neutron matter near nuclear densities, an upper limit to the maximum mass of a stable neutron star is derived. (auth)

12779 POST-NEWTONIAN STUDY OF DIFFERENTIALLY ROTATING POLYTROPES. Seguin, F. H. (California Inst. of Tech., Pasadena). Astrophys. J.; 179: No. 1, 289-308(1 Jan 1973).

Chandrasekhar's post-Newtonian equations of hydrodynamics are applied to a self-gravitating polytropic fluid in rapid, axisymmetric, differential rotation, and used to construct an iterative method of the "self-consistent field method" type which can be used on the computer to find equilibrium configurations. The equation of hydrostatic equilibrium is integrated to give an algebraic equation which is, in principle, as simple as the analogous Newtonian equation. Expressions are given for the mass and binding energies of configurations, and the domain of validity of the post-Newtonian approximation is discussed. The geometrical characteristics of the rotation are investigated. It is demonstrated that the distributions of angular velocity which occur in equilibrium configurations always have the property that their level surfaces coincide with the level surfaces of angular momentum per unit rest mass, and that these surfaces do not correspond to surfaces

whose intrinsic geometries are those of a cylinder. This is qualitatively different from the situation in Newtonian theory, where the fluid in equilibrium configurations always rotates on cylinders. (auth)

12780 SPECTRUM OF HERBIG–HARO OBJECT NO. 1. Boehm, K. H.; Perry, J. F.; Schwartz, R. (Univ. of Washington, Seattle). Astrophys. J.; 179: No. 1, 149-60(1 Jan 1973).

A spectroscopic and spectrophotometric study of Herbig–Haro Object No. 1 was carried out using four image-tube spectra covering the spectral range 3700 Å $\lesssim \lambda \lesssim$ 6850 Å. New line identifications include additional [Fe II] and [N II] lines as well as the Balmer lines H10, H11, and H12. (W.D.M.)

12781 FLARE STARS IN THE PLEIADES. Ambartsumyan, V. A.; Mirzoyan, L. V.; Parsamyan, E. S.; Chavushyan, O. S.; Erastova, L. K. (Byurakan Astrophysical Observatoryy, USSR). Astrophysics (Engl. Transl.); 6: No. 1, 1-10(1970).

Translated from Astrofizika; 6: No. 1, 7-30(1970).

Data were collected on 45 new flare stars in the Pleiades, discovered mainly during the observational season 1968–1969 at the Tonantzintla, Asiago, Byurakan, Budapest, and Alma-Ata Observatories. Together with the 100 flare stars in the previous lists of the Tonantzintla Observatory the total number of flare stars discovered in the region of the Pleiades has now reached 146. One of them (H II 2411) belongs to the Hyades. Of the remaining 145 stars, 123 have shown one flare, 16 have shown two flares, and 6 more than two flares. A special analysis of flare stars was carried out and it was found that the total number of flare stars in the Pleiades should be greater than 600. The distribution of flare stars can be satisfactorily represented by the sum of two Poisson distributions with different mean frequencies. Almost all the members of the Pleiades with $V \geq 13.3$ are flare stars. A sharp boundary between photographically observed flare stars and nonflaring stars occurs at V = 13.29. The mean frequency of large flares with amplitudes in excess of 0.6m is of the order of $4 \cdot 10^{-4}$ h^{-1} for the majority of the stars. The total mass of the Pleiades is greater than the dynamic mass determined from the virial theorem (400 $M_\odot$). The difference is due to an outer envelope consisting of stars of lower luminosity (mostly flare stars). (auth)

12782 PERCENTAGE OF FLARE STARS AMONG RW AURIGAE TYPE VARIABLES IN THE ORION ASSOCIATION. Ambartsumyan, V. A. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 6: No. 1, 11-13(1970).

Translated from Astrofizika; 6: No. 1, 31-8(1970).

A statistical study of a sample of RW Aurigae type variables in the Orion association shows that only about one-quarter of these variables with amplitudes exceeding one stellar magnitude are flare stars with flares observable by the photographic method. It is argued that such flares occur only during the late stages of variability. (auth)

12783 PHOTOGRAPHIC PHOTOMETRY OF NGC 6866. Hidajat, B.; Sutantyo, W. (Bosscha Observatory, Java, Indonesia). Proc., Inst. Teknol. Bandung; 6: No. 3, 89-103(1972).

Magnitudes and colors in the UBV photometric system were determined for 575 stars in and around NGC 6866. The color–color relation of the cluster stars provided an estimate of interstellar reddening of 0.16 mag. The distance of the cluster was found to be 1336 pc. The age, as determined from the evolutionary deviation curve, is approximately 2.5×10^8 years. (auth)

12784 MOLECULAR MYSTERIES OF RED GIANTS. Clayton, D. D. (Rice Univ., Houston, TX). Comments Astrophys. Space Phys.; 4: No. 5, 137-40(1972).

Major progress in understanding the evolution of red giants may be imminent. The analysis of their atmospheres is very difficult, because it has been shown that they are predominantly molecular. Of primary importance is the finding that the C/O ratio determines whether C or O compounds are most prevalent in the atmospheres. This is due to the great stability of CO, which is formed until either C or O is exhausted, leaving the more abundant residual free to form other compounds. An attempt is made to outline several related advances that have or promise to provide important constraints on their evolution. (WDM)

12785 FULLY COVARIANT THEORY OF CHARGED SUPERFLUIDS. Papini, G.; Miketinac, M. J. (Univ. of Saskatchewan, Regina). Lett. Nuovo Cim.; 5: No. 15, 981-4(9 Dec 1972).

An attempt is made to develop a fully covariant theory of charged superfluids by considering the effects of strong magnetic and gravitational field effects in neutron stars. (WDM)

12786 LIGHT VARIATIONS OF AG PEG BETWEEN 1962 AND 1967. Belyakina, T. S. (Crimean Astrophysical Observatory, Semferopol, USSR). Astrophysics (Engl. Transl.); 6: No. 1, 22-9 (1970).

Translated from Astrofizika; 6: No. 1, 49-64(1970).

The results of three-color photoelectric photometry of AG Peg for 1964–1967 are reported. The resultant photoelectric light curve for AG Peg in yellow light for 1962–1967 is given, and is in satisfactory agreement with a sinusoid having a period of 800 days and an amplitude of 0.3 m. The light of AG Peg during 1962–1967 was found to vary simultaneously in all the spectral regions investigated. The mean amplitude of the variation in yellow and blue rays was 0.3 m and in the ultraviolet 0.5 m. In view of the binary nature of AG Peg the variation of this light can be explained by the orbital motion of the cold component M3 III, whose hemisphere facing the hot component W N6 has a higher luminosity than the other hemisphere. Approximate estimates showed that the nature of this emission in the yellow and blue parts of the spectrum is due to the heating of the photosphere of the giant M3 III by the radiation from the hot component. In the ultraviolet this is due to the ionization of the outer layers of the atmosphere of M3 III by the radiation from WN6 with wavelengths between 228 and 912 Å. It is suggested that the periodic variations in the light of AG Peg became observable relatively recently. The calculated stellar magnitudes of the components showed that the luminosity of M3 III is 8.9 m in a system close to V, whereas that of WN6 is 10.0 m. (auth)

12787 SPECTROPHOTOMETRIC STUDIES OF MWC 84. Chkhikvadze, Ya. N. (Tbilisi State Univ., USSR). Astrophysics (Engl. Transl.); 6: No. 1, 30-5(1970).

Translated from Astrofizika; 6: No. 1, 65-76(1970).

Spectrograms obtained with the 70-cm-meniscus telescope at the Abastumani Astrophysical Observatory were used to identify the emission lines of the star MWC 84 and to determine their relative intensities and the intensities in the continuous spectrum. The envelope is transparent to the Balmer lines. The enhancement of emission lines belonging to the singlet series of neutral helium relative to the triplet lines is more clearly defined than in gas nebulas. The estimated distance of the star, the amount of absorption, and the luminosity were estimated to be 1 kpc, 1.5 m, and +0.5 m, respectively. The star belongs to the spectral class O8 (T = 40,000°K) and contains an anomalously high amount of helium. (auth)

12788 POLARIMETRIC STUDIES OF LONG-PERIOD VARIABLES. Vardanyan, R. A. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 6: No. 1, 36-41 (1970).

Translated from Astrofizika; 6: No. 1, 77-87(1970).

A quantitative analysis of the results of polarimetric observations on late-type stars (Sp: M, N, R, S) is reported. The dependence of the polarization of light from AB Cyg, AK Peg, V CVn, and RX Boo on the intensity and wavelength is discussed. (auth)

12789 SCATTERING OF LIGHT IN A MEDIUM WITH A MOVING BOUNDARY. Leonov, V. V. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 6: No. 1, 42-6(1970).

Translated from Astrofizika; 6: No. 1, 89-100(1970).

The scattering of light in a one-dimensional semiinfinite medium with a moving boundary is considered. A differential equation is obtained for the probability of escape of a photon from the medium for arbitrary t_1 and t_2. Exact expressions are found for the probabilities of escape and reflection of a photon from the medium for $t_2 \gg t_1$. (auth)

12790 GRAVITATIONAL CONTRACTION OF A SPHERICAL CLOUD. Zel'dovich, Ya. B.; Kazhdan, Ya. M. (Inst. of Applied Mathematics, Moscow). Astrophysics (Engl. Transl.); 6: No. 1, 50-5(1970).

Translated from Astrofizika; 6: No. 1, 109-22(1970).

Two problems are discussed: (1) contraction of a gas at a finite pressure, which is initially uniformly distributed in a sphere, and (2) contraction of cold gas or dust ($p_0 = 0$), taking into account a nonuniform density distribution. In the first problem the asymptotic properties of the motion are derived (a) in the neighborhood of the boundary of the rarefaction wave travelling toward the center, and (b) in the neighborhood of the center at times corresponding to the focusing of the rarefaction wave for initial densities $\rho_0 \to 0$. The final state of the gas is discussed for $t \to \infty$. In the second problem the asymptotic motion in the neighborhood of the center behind the reflected shock wave is investigated. (auth)

12791 VELOCITY VARIATION OF A STAR AS A PURELY DISCONTINUOUS RANDOM PROCESS. I. ZERO-MASS STARS. Kaliberda, V. S.; Petrovskaya, I. V. (Leningrad State Univ.) Astrophysics (Engl. Transl.); 6: No. 1, 63-8(1970).

Translated from Astrofizika; 6: No. 1, 135-47(1970).

The variation of the velocity modulus of a star in a system is discussed as a purely discontinuous random process. The evolution of the stellar velocity distribution function for zero-mass stars in an open cluster is investigated using the second Kolmogo-

rov–Feller equation without taking into account the regular potential. The rate of escape of zero-mass stars and the energy carried off by them are calculated. (auth)

12792 MASS FORMULA FOR KERR BLACK HOLES. Smarr, L. (Univ. of Texas, Austin). Phys. Rev. Lett.; 30: No. 2, 71-3 (8 Jan 1973).

A new mass formula for Kerr black holes is deduced, and is contrasted to the mass formula which is obtained by integrating term by term the mass differential and which consists of three terms interpreted, respectively, as the surface energy, rotational energy, and electromagnetic energy of the charged rotating black hole. A comparison is suggested between a rotating black hole and a rotating liquid drop which leads to a speculation that Kerr black holes may develop instabilities. (auth)

12793 EVOLUTION OF THE ASYMPTOTIC BRANCH OF A GLOBULAR-CLUSTER STAR OF LOW MASS. Mengel, J. G. New Haven; Yale Univ. (1972). 53p. University Microfilms Order No. 72-31,452.

Thesis.

A theoretical study of the asymptotic-branch evolution of a globular-cluster star of 0.60 $M_\odot$ with the composition X = 0.732, Z = 0.001 in the envelope was made. The major objective was to determine whether the readjustment of the envelope following the flashes in the thermally unstable helium-burning shell can cause the track in the H–R diagram to depart from the asymptotic branch. The results suggested that of the approximately 12 relaxation cycles of this star only the last 1 or 2 cycles on the asymptotic branch will result in loops extending into the instability strip. Additional computations for the composition X = 0.600, Z = 0.001 indicated that increasing the helium abundance in the envelope will enhance the blueward extent of the loops, particularly during the last several cycles. Departures from the asymptotic branch during earlier cycles are very small for both compositions. Both the final crossing of the instability strip when the star evolves off the asymptotic branch, together with the crossings associated with loops, provide a possible explanation for the presence in globular clusters of Cepheids with periods of the order of 10 days. A mild correlation between the occurrence of these variables and blueness of the horizontal branch is predicted, and the effect of a mass spread on the asymptotic branch is discussed. The post-asymptotic-branch evolution of a 0.60 $M_\odot$ star with the composition X = 0.732, Z = 0.001 was followed, and a helium shell flash occurring during this stage was studied. The hydrogen-burning shell becomes thermally unstable when its outward progression has reduced the mass remaining above it to 0.001 $M_\odot$. (Diss. Abstr. Int., B)

12794 RADIATIVE PROCESSES IN AN INTENSE MAGNETIC FIELD. Strange, D. L. P. Pasadena, CA; California Inst. of Tech. (1972). 130p. University Microfilms Order No. 72-30,834.

Thesis.

Three astrophysical problems relating to the intense magnetic fields associated with neutron stars (i.e., 10^{12} gauss) and white dwarfs (i.e., 10^8 gauss) were studied. (1) The radiation rate for nonrelativistic bremsstrahlung in 10^{12} gauss was computed by both quantum-mechanical and classical methods. (2) The electron energy levels and orbits for hydrogen in 10^{12} gauss were calculated with variational techniques. (3) Cyclotron emission and absorption in a magnetic field of 10^8 gauss were studied as a possible mechanism for the observed degree of circular polarization in the optical emission from white dwarfs. A few simple models explain some of the quantitative and qualitative aspects of the polarization data. (TSS) (Diss. Abstr. Int., B)

12795 NEW HELIUM-RICH B-TYPE STAR. Drilling, J. S. (Louisiana State Univ. Observatory, Baton Rogue). Astrophys. J.; 179: No. 1, L31-2(1 Jan 1973).

Star No. 3378 in the catalog of Stephenson and Sanduleak, which lies near l = 329°, b = +6°, has been identified as a helium star. A description of the spectrum at 125 Å mm^{-1} is given along with the radial velocity of the star and its apparent magnitude and colors on the UBV system. Radial-velocity measurements of the interstellar H and K lines set a lower limit of 1500 pc on the distance of the star, whereas the strengths of these lines indicate a lower limit of 5000 pc. These distances correspond to absolute magnitudes of $M_V = -1.5$ and $M_V = -4$, respectively. (auth)

12796 HD 215441 AND 53 CAMELOPARDALIS: INTRINSIC POLARIZATION OF Hβ AND THE CONTINUUM. Kemp, J. C.; Wolstencroft, R. D. (Univ. of Hawaii, Honolulu). Astrophys. J.; 179: No. 1, L33-7(1 Jan 1973).

Variable linear polarization was detected in the Hβ absorption line of the magnetic Ap stars HD215441 and 53 Cam, probably caused by the transverse Zeeman effect at least in the latter case. The relationship to the continuum polarization proved that both the Hβ and line polarizations are intrinsic in the two stars. (auth)

12797 IRC + 10420: ANOTHER ETA CARINAE. Humphreys, R. M. (Steward Observatory, Tucson, AZ); Strecker, D. W.; Murdock, T. L.; Low, F. J. Astrophys. J.; 179: No. 1, L49-52(1 Jan 1973).

At long wavelengths (1 to 22 μ) the infrared source IRC + 10420 resembles very closely the peculiar object η Car. Photographic spectra of +10420 show it to be a very high luminosity star with spectral type about F8 or G0. This is remarkably similar to the cF5 absorption-line spectrum reported for η Car in 1892. (auth)

12798 RAVNOVESNYE KONFIGURATSII VYROZHDENNYKH GAZOVYKH MASS. (Equilibrium Configurations of Degenerate Gas Masses). Saakyan, G. S. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Mathematicheskoi Literatury (1972). 344p.

This monograph on superdense stellar masses reviews the relativistic theory of gravitation and then treats the properties of matter at low temperatures and high densities, degenerate electron gas, and nuclear reactions in cold plasma. Basic characteristics of an ideal degenerate baryon gas and of a real baryon gas are set forth. The nonrelativistic theory of superdense stellar configurations (white dwarfs) and the relativistic theory of baryon configurations are presented. Internal structure and mass defects of baryon configurations, the generalized theory of Einstein's gravitation, and how the latter relates to configurations of degenerate gas masses form the closing chapters of the book. (282 references) (KSW)

12799 CATALOGUE OF STELLAR DIMENSIONS. Wesselink, A. J.; Paranya, K.; DeVorkin, K. (Yale Univ., New Haven). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 257-89(Nov 1972).

The catalog presents angular diameters of 2392 stars, linear diameters, absolute magnitudes, and spectroscopic parallaxes for 2301 stars. The data that were used for the calculation of the diameters are reviewed and previous attempts of computing stellar diameters, using the color and the surface brightness, are briefly discussed. For the diameters in the present catalog, the color index is used; the method, based on a calibrated surface brightness, was used before by Wesselink (1969). The quantities T_e and BC were not used in the present work. The accuracy of the catalog is discussed in detail. Frequency distributions of log d, log R, M_V, and log p are shown graphically. (auth)

12800 SPECTRUM OF o^2 CMa, B3Ia. I. EQUIVALENT WIDTHS AND LINE PROFILES. van Helden, R. (Astronomical Inst., Utrecht). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 311-29(Nov 1972).

Eleven spectrograms with a dispersion of 2.2 Å mm^{-1} in the blue and 17.7 Å mm^{-1} in the infrared spectral region were used to perform an analysis of the spectrum of o^2 CMa, B3Ia. Equivalent widths and identifications of 285 spectral features in the wavelength interval 3500 to 8870 Å are given as well as the profiles of 60 absorption lines. (auth)

12801 A-TYPE SUPERGIANTS: A LIST OF LINE INTENSITIES AND RADIAL VELOCITY MEASUREMENTS. Aydin, C. (Astronomical Observatory, Trieste, Italy). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 331-54(Nov 1972).

The equivalent widths of the spectral lines used for the construction of the curve of growth for five A-type supergiants and the radial velocity of the Balmer and metallic lines for the same stars are given. (auth)

12802 PHOTOMETRY OF ELEVEN YOUNG OPEN STAR CLUSTERS. Moffat, A. F. J. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 355-83(Nov 1972).

Photographic UBV magnitudes to V ~ 17m were obtained for all stars contained in regions defined by the open clusters: NGC 6823, NGC 6830, NGC 6834, NGC 7235, NGC 457, NGC 581, NGC 654, NGC 663, IC 1805, IC 1848, and NGC 1893. Magnitudes of field stars were measured in additional regions of similar area located outside and symmetrically surrounding each cluster. Comparison of the cluster and field areas made it possible to select with high probability individual bright cluster members of spectral type earlier than B 7–9. Their individually derived reddening values enabled a study of extinction across each cluster and of the upper part of the cluster sequence in the color–magnitude diagrams. The fainter part of the cluster sequence was obtained by statistical subtraction of the respective cluster and field regions. Combining both parts led to a derivation of accurate distances and the recalibration of the absolute magnitudes and colors of the probable member supergiants. (auth)

12803 TWO UBV PHOTOELECTRIC SEQUENCES IN CYGNUS. Stenholm, B.; Soederhjelm, S. (Lund Observatory,

Sweden). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 385-91 (Nov 1972).

Magnitudes and colors in the UBV system are given for 73 stars. The magnitude range is approximately V = 7 to V = 13 and the stars are situated near α = 21h20m, δ = +50°. (auth)

12804 STELLAR STRUCTURE IN NONUNIFORM ROTATION. 2. PROPERTIES OF A FAST ROTATING STAR AVERAGED OVER SPHERES. Tuominen, I. V. (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 392, 1-26 (1972).

The structure of a main-sequence star in fast differential rotation, with different amounts and different distributions of angular momentum, is studied. A technique in which the variables are integrated over spheres, including first order perturbing terms only, is applied. The equilibrium equations reduce to a simple form, which is essentially the same as in the case of spherical symmetry. The results, however, give only the total luminosity and the mean radius of the star. The models for a 2.5 $M_\odot$ star show a strong decrease of luminosity when the central rotation increases. Comparison with published models of larger masses, derived by different techniques, shows that the decrease depends only on the ratio of the total angular momentum to the square of mass, and is practically independent of the distribution of angular momentum. The volume of the star decreases when the ratio of central to surface angular velocity increases, becoming at a certain stage smaller than the volume of the nonrotating star. The consequence of these changes on the luminosity-effective temperature diagram is that the displacement of a model from the zero-rotation main sequence upwards is smaller for differentially than for uniformly rotating star, contrary to an earlier result, and is downwards if the ratio of central to surface angular velocity is sufficiently large. (auth)

12805 COMPLETENESS OF THE CATALOG OF NEARBY STARS. Seidov, Z. F. Tr. Shemakh. Astrofiz. Observ., Akad. Nauk Azerb. SSR; No. 4, 14-16(Apr 1971). (In Russian).

The data from Gliese's "Catalog of Nearby Stars" (1969) on 1,049 objects (characterized by parallax values ≥0.050) were treated graphically using logarithmic functions of their parallaxes. The results of this study demonstrated the incorrectness of formulas showing the spatial density of stars at known distances from the solar system, which had been advanced by Arakelyan (1968, 1970), and Esoyan and Seidov (1971). (KSW)

12806 DEPENDENCE OF THE POPULATION OF HIGH ENERGY LEVELS OF HYDROGEN ATOMS ON THE VELOCITY OF TURBULENT MOTION IN CHROMOSPHERIC FLARES. Guseinov, R. E. Tr. Shemakh. Astrofiz. Observ., Akad. Nauk Azerb. SSR; No. 4, 10-13(Apr 1971). (In Russian).

An expression is given for determining the velocity of turbulent motion and the decrement of the Balmer series for hydrogen in chromospheric flares relative to the intensity of radiation. The effect of the turbulent velocity on the energy of electrons participating in collisions and also on the quantity which characterizes the probability of forming neutral hydrogen during the process of the encounter of two electrons with a proton is discussed. (KSW)

12807 CYANOACETYLENE CLOUD IN SAGITTARIUS B2. McGee, R. X.; Newton, L. M.; Batchelor, R. A.; Kerr, A. R. (CSIRO, Sydney). Astrophys. Lett.; 13: No. 1, 25-32(Jan 1973).

A new 3.4-cm cryogenic receiver operating on the Parkes 64-m radio telescope was used to detect the F = 1 → 1, F = 2 → 1, F = 0 → 1 hyperfine lines of the J = 1 → 0 transition of the cyanoacetylene molecule in Sagittarius B2. On the assumption that the natural line frequency of the principal component (F = 2 → 1) is 9098.332 MHz, the radial velocity at the central position is +64.4 km sec^{-1}. The distribution of cyanoacetylene in Sgr B2 was mapped and compared with that of other molecules. The HCCCN line was not detected in 14 other southern Milky Way sources. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 12081, 12764, and 12924.

12808 (N-72-22807) SPECTRA OF TEN GALACTIC X-RAY SOURCES IN THE SOUTHERN SKY. Cruddace, Ray; Bowyer, Stuart; Lampton, Michael; Mack, John; Margon, Bruce (California Univ., Berkeley). Oct 1971. 35p. (NASA-CR-126169). NTIS.

Data on ten galactic x-ray sources were obtained during a rocket flight from Brazil in June 1969. Detailed spectra of these sources were compared with bremsstrahlung, blackbody, and power law models, each including interstellar absorption. Six of the sources were fitted well by one or more of these models. In only one case were the data sufficient to distinguish the best model. Three of the sources were not fitted by any of the models, which suggests that more complex emission mechanisms are applicable. A comparison of the results with those of previous investigations provides evidence that five of the sources vary in intensity by a factor of 2 or more, and that three have variable spectra. New or substantially improved positions were derived for four of the sources observed. (auth)

12809 (N-72-24849) ACTIVITY IN GALAXIES AND QUASARS. Sturrock, P. A. (Stanford Univ., Calif. Inst. for Plasma Research). Nov 1971. 36p. (NASA-CR-126650; SU-IPR-443). NTIS.

Activity in galaxies and quasars is interpreted in terms of plasma processes occurring in the magnetosphere of a magnetoid model. The magnetoid is comprised of a core and an annulus rotating about a common axis with different angular velocities. It is conjectured that the transition from a closed force field configuration to an open one will be affected by an MHD eruptive instability, and that such eruptions lead to high-velocity clouds of cool gas, identified with clouds producing absorption lines in quasars. The ejection of radio clouds from galaxies and quasars is attributed to galactic flares. Current sheets contain mildly relativistic electrons moving in directions partially transverse to the magnetic field. Synchrotron radiation from these electrons is held responsible for the nonthermal radiation from quasars and certain galaxies. It is proposed that minor instabilities of the current sheets are responsible for fluctuations in the nonthermal luminosity and for small scale radio bursts sometimes observed. (auth)

12810 (N-72-24868) HIGH-ENERGY ASTRONOMY OBSERVATORY MISSION C, PHASE A. VOLUME 1. EXECUTIVE SUMMARY. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Jan 1972. 117p. (NASA-TM-X-64652). NTIS.

The primary objective of HEAO-C is a detailed study of high-energy sources, using grazing incidence x-ray telescopes and a spacecraft pointing accuracy of ±1 arc minute. A principal design goal for the HEAO-C spacecraft was to maximize commonality with the spacecraft designed for Missions A and B; technical transfusion between the designs required the Phase A study to be accomplished in parallel with Phase B definition of the precursor spacecraft. Plans call for a HEAO-C launch between 1 and 1½ years after the launch of HEAO-B. The HEAO-C will be launched on the Titan 3D and placed into a 270-nautical-mile circular orbit with a 28.5 degree inclination; the Phase A baseline concept weighs under 16000 pounds, carries three grazing incidence x-ray telescopes with multiple focal plane experiments plus several supporting experiments and is designed for a two-year operational life. The HEAO-C is a candidate for early satellite retrieval with the space shuttle. (auth)

12811 RECOMBINATION RADIO LINES IN H I REGIONS. Gosachinskii, I. V. (Special Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 537-9(1972).

Translated from Astron. Zh.; 49: No. 3, 658-61(1972).

If the H157 α radio line detected in NGC 2024 is formed in an HI region, an ionization source would be required that is an order of magnitude more powerful than the average for the galactic plane, according to measurements of the H271 α recombination line. (auth)

12812 POSSIBLE CAUSE OF THE VARIATIONS OF THE INTENSITY OF AN INTERSTELLAR MASER. Strel'nitskii, V. S. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 529-31(1972).

Translated from Astron. Zh.; 49: No. 3, 649-52(1972).

It is pointed out that a mechanism associated with the recoil of the emitting molecules could be responsible for the variations in the intensity of interstellar maser sources. (auth)

12813 EFFECT OF THOMSON SCATTERING ON THE EMISSION SPECTRUM OF AN OPTICALLY SEMIOPAQUE PLASMA. Shakura, N. I. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 532-3(1972).

Translated from Astron. Zh.; 49: No. 3, 652-4(1972).

A study was made of the emission from a homogeneous, optically semiopaque cloud when multiple Thomson scattering, i.e., scattering without a change in the frequency, occurs. The characteristic points of inflection in the spectrum make it possible to determine the parameters of the cloud. (auth)

12814 OBSERVATIONS OF MASER RADIO SOURCES WITH AN ANGULAR RESOLUTION OF 0 .0002". Burke, B. F. (Massachusetts Inst. of Tech., Cambridge); Johnston, K. J.; Efanov, V. A.; (and others). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 379-82 (1972).

Translated from Astron. Zh.; 49: No. 3, 465-9(1972).

Sources of maser radio emission in the water-vapor lines were measured with a radio interferometer having a Haystack–Simeiz baseline and providing a record resolution of 0.0002''. Preliminary results are reported. (auth)

12815 FINE STRUCTURE OF PULSAR RADIO SPECTRA. Shitov, Yu. P. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 383-92(1972).

Translated from Astron. Zh.; 49: No. 3, 470-82(1972).

For seven pulsars, measurements are reported of the frequency-correlation radius $\delta\nu_0$ of the spectral fine structure due to scattering of their radio emission by irregularities in the interstellar plasma. The observations were made at the Pushchino Radio Astronomy Station of the Lebedev Institute with a 12-channel spectrometer at 105 and 63 MHz. These measurements, in conjunction with those by other authors, show that the theoretical fourth-power frequency dependence $\delta\nu_0 \propto \nu^4$ holds for the pulsars CP 1133, CP 1919, CP 0834, AP 1237, and HP 1507 in the 63-408 MHz range. For CP 0950 and CP 0808 this law is violated, as discovered previously. For CP 0950, $\delta\nu_0 \propto \nu^2$ in the range mentioned, while for CP 0808 the curve has a bend, with $\delta\nu_0 \propto \nu^4$ at 63 to 105 MHz and $\delta\nu_0 \propto \nu^{2.5}$ at 105 to 408 MHz. The measurements indicate that for some pulsars the quadratic dependence of $\delta\nu_0$ on dispersion measure is not satisfied, suggesting that the inhomogeneous interstellar plasma presumably has anisotropic properties. The Faraday effect in the direction of CP 1133 yields a longitudinal magnetic-field component $H_\parallel = (1.2 \pm 0.2) \cdot 10^{-6}$ gauss. During individual observing sessions the polarization angle of the subpulses of CP 1133 was found to suffer discrete changes by ± 90°. (auth)

12816 SUPERNOVA REMNANT IN THE SMALL MAGELLANIC CLOUD. Mathewson, D. S. (Australian National Univ., Canberra); Clarke, J. N. Astrophys. J.; 178: No. 3, L105-7(15 Dec 1972).

A combination of radio and optical techniques was used to identify a supernova remnant in the emission region N19 in the bar of the Small Magellanic Cloud. This is the first supernova remnant to be discovered in that galaxy. (auth)

12817 OBSERVATIONS OF VELA XR-1 BY THE UCSD X-RAY TELESCOPE ON OSO-7. Ulmer, M. P.; Baity, W. A.; Wheaton, W. A.; Peterson, L. E. (Univ. of California, San Diego). Astrophys. J.; 178: No. 3, L121-6(15 Dec 1972).

The OSO-7 UCSD hard x-ray telescope scanned Vel XR-1, located at $\alpha = 9h0.3m$, $\delta = -40.4°$, from December 17, 1971, to January 22, 1972. The flux in the 7 to 26 keV range showed evidence for periodic intensity variations of at least a factor of 20, with a period of 8.7 ± 0.2 days. The low-intensity state lasted 1.7 ± 0.2 days and began at epoch December 1971 25.8. The spectrum for Dec. 27–31, 1971 was nearly flat on a log–log plot from ~7 to 26 keV, and had a flux of 1×10^{-2} to 6×10^{-3} photons $(cm^2\ s\ keV)^{-1}$ depending on the source strength. The average intensity in the 22 to 60 keV range was ~2.6 to 1×10^{-3} photons $(cm^2\ s\ keV)^{-1}$. Although shorter and longer periodicities were not observed in this analysis, nevertheless this object is believed to be an eclipsing-binary companion to a larger star, similar to Cen X-3 or Her X-1. (auth)

12818 PARALLAX AND PROPER MOTION OF SCORPIUS X-1. van Altena, W. F. (Univ. of Chicago). Astrophys. J.; 178: No. 3, L127-8(15 Dec 1972).

The absolute trigonometric parallax of the optical object identified with Sco X-1 is found to be $\pi = -0.001 \pm 0.006''$ (s.e.) as determined from plates taken with the Yerkes Observatory 40-inch (102-cm) refractor. This suggests a distance to Sco X-1 greater than 200 pc. The absolute proper motion determined from these plates is $\mu_\alpha = -0.011 \pm 0.006''$ per year and $\mu_\delta = -0.018 \pm 0.003''$ per year (s.e.). This motion is consistent with reflex solar motion or membership in the Sco–Cen association and agrees with that determined by Sofia, Eichhorn, and Gatewood. However, Sco X-1 cannot be assumed to be a member of the association on the basis of proper motion alone, since the directions of the solar antapex and the motion of the association are almost coincident. (auth)

12819 ANOMALOUS HYPERFINE LINES IN FORMALDEHYDE IN A DUST CLOUD. Dieter, N. H. (Univ. of California, Berkeley). Astrophys. J.; 178: No. 3, L133-7(15 Dec 1972).

Abnormal intensities were found in the hyperfine lines of the 6-cm formaldehyde transition observed in dust clouds. The $0 \rightarrow 1$ line was enhanced in at least one cloud by an order of magnitude. (auth)

12820 NRAO 5-GHz RADIO SOURCE SURVEY. III. THE 140-FT STRONG SOURCE SURVEY. Pauliny-Toth, I. I. K. (Max-Planck-Institut fuer Radioastronomie, Bonn); Kellermann, K. I. Astron. J.; 77: No. 10, 797-809(Dec 1972).

The 140-ft telescope at the National Radio Astronomy Observatory has been used to extend the 5-GHz strong source (S) survey over an area of 1.14 ster. Some 240 sources have been detected in this region, of which 135 are above the completeness limit of 0.6 f.u. The distribution of spectral indices for sources above the completeness limit is much broader than for samples selected from long-wavelength surveys, owing to an increase in the fraction of compact sources with flat spectra. For about half of the sources selected at 6 cm, the spectral index $\alpha > -0.5$. Analysis of the dependence of the spectral index on the flux density shows that, as expected from the 408-MHz number counts and spectral index distribution, at 5 GHz there are fewer flat spectra among the weak sources than among the stronger ones. The spectral index distributions for the identified galaxies and quasars show the familiar forms: the galaxies have a strong concentration near $\alpha = -0.8$ with a small tail extending toward flat spectra. The quasars show a much broader distribution of indices, but the fraction (80%) of quasars having flat spectra ($\alpha > -0.5$) is much greater than that found in the low-frequency surveys. The number–flux density relation for various groups of sources selected from the 5-GHz survey show that the anomalously steep slope is confined to (a) unidentified sources, (b) sources with steep spectra ($\alpha < -0.5$), and (c) sources located in the north galactic hemisphere. Sources identified with radio galaxies or quasars, or which have flat spectra, or which are in the south galactic hemisphere all show a number-flux density slope near −1.5. (auth)

12821 MEASUREMENTS OF THE INTEGRATED STOKES PARAMETERS OF COMPACT RADIO SOURCES. Berge, G. L.; Seielstad, G. A. (California Inst. of Tech., Pasadena). Astron. J.; 77: No. 10, 810-18(Dec 1972).

The complete state of the integrated radiation from several compact radio sources was measured at three frequencies and at several epochs: 1420 MHz (1971.0), 1602 MHz (1971.1), and 5000 MHz (1971.5, 1971.8, and 1972.0). The latter represents the beginning of a program, still in progress, to monitor selected sources periodically at 5000 MHz. Although circular polarization was the primary interest, all four Stokes parameters were, in fact, obtained, and all of the results are presented. Of 54 radio sources observed in one or more of the observing sessions, circular polarization was detected in 12 and suspected in six others. It appears that magnetic field estimates based on the observed circular polarization are significantly larger than those deduced from synchrotron self-absorption. (auth)

12822 7.8-GHz FLUX DENSITY MEASUREMENTS OF VARIABLE RADIO SOURCES. Dent, W. A.; Kojoian, Gabriel (Univ. of Massachusetts, Amherst). Astron. J.; 77: No. 10, 819-28(Dec 1972).

Measurements of the variation in the 7.8-GHz flux density of 22 extragalactic radio sources between 1969.0 and 1971.7 are presented. (auth)

12823 OPTICAL MONITORING OF QUASISTELLAR OBJECTS. I. Lue, P. K. (Western Connecticut State Coll. Observatory, Danbury). Astron. J.; 77: No. 10, 829-44(Dec 1972).

Observational results of 25 quasistellar objects (QSO's) from the Yale Observatory optical patrol program of QSO's are given. Light curves and magnitudes are presented for all objects, generally brighter than 17th magnitude. The program covered a period of about five years, during which time more than a thousand observations were obtained. Fine-structure light curves are given for 3C 345 and 3C 454.3. A color correction between Yale photographic magnitude and Johnson's B-magnitude is suggested. There is a good correlation of optical variation with the radio variability at 2-cm to 6-cm wavelength. From the Yale observations, at least 25% to 30% of the QSO's are varying, with an amplitude of greater than 1.0 mag, and 50% of the other objects on the Yale list are variables whose magnitude has changed by more than 0.3 mag. The remaining objects have no significant variation, although in several occasions variations have been detected in the earlier investigations. No apparent periodicities can be established from the last five years of observations which may either indicate that the duration of the observation was not long enough to detect periods, or that the variable characteristics of QSOs are probably different from pulsars. (auth)

12824 BRIGHTNESS TEMPERATURES IN THE SOUTHERN SKY AT 408 MHz. Price, R. M. (Massachusetts Inst. of Tech., Cambridge). Astron. J.; 77: No. 10, 845-8(Dec 1972).

Absolute brightness temperatures for a number of regions of the southern sky were measured on an l-b grid with 15° spacing. The measurements were taken at a nearly constant zenith angle and were related to the brightness temperature observed at the south celestial pole, at the same zenith angle. Repeatability and analysis of the drift characteristics of the receiver indicated that the rms error in brightness temperature of any point with respect to that at the south celestial pole should be less than 1 K.

This led to absolute brightness temperatures with rms errors of less than ±2.7 K. (auth)

12825 DETECTION OF SIX PULSARS AT 2.8 cm. Wielebinski, R. (Max-Planck-Institut fuer Radioastronomie, Bonn); Sieber, W.; Graham, D. A.; Hesse, H.; Schoenhardt, R. E. Nature (London) Phys. Sci.; 240: No. 102, 131-2(11 Dec 1972).

The observations reported are stated to be the first made with the MPHR 100m radio telescope at 2.8cm wavelength. Details are given of the operation of the equipment. Amongst the six pulsars detected were the intense pulsars CP 0329 and JP 2021. One of the surprises was the detection of BP 2020 at 2.8cm. The other pulsars detected were AP 0823, CP 1133, and PSR 1929. The last named was found to be highly linearly polarized at 2.8cm. Values of maximum flux and mean pulse energy are tabulated, but it is thought that these values may change substantially with further observing sessions spaced well apart. The present observations were made in October 1972. Only after consistent sets of observations are completed at this and other wavelengths, however, will a meaningful spectrum be derived. Amongst conclusions reached is that the spectrum of pulsars is very steep at high frequencies. Of the six pulsars investigated CP 1133 showed the steepest spectrum and JP 2021 the flattest spectrum at frequencies higher than 1420 MHz. (UK)

12826 DIMENSIONS OF THE BINARY SYSTEM HDE 226868 = CYGNUS X-1. Bolton, C. T. (Univ. of Toronto). Nature (London) Phys. Sci.; 240: No. 102, 124-7(11 Dec 1972).

Recent observations of the binary star HDE 226868, which is believed to be associated with Cygnus X-1, are combined with data already published to obtain improved orbital elements for the binary system. The data imply that the secondary is a black hole. (auth)

12827 OPTICAL POSITIONS FOR 21 3C OBJECTS. Argue, A. N.; Kenworthy, C. M. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 160: No. 2, 197-211(1972).

Optical positions relative to AGK have been obtained for 21 3C objects using (i) direct photographs taken with the Cambridge $^{17}/_{24}$-inch Schmidt telescope; (ii) positions measured by Murray, Tucker, and Clements (1971) and modified by recalibration of their secondary reference stars by the present authors; and (iii) positions measured from 48-inch Mt Palomar Schmidt telescope plates. The external standard errors have been estimated by comparison with the most accurate radio positions resulting in: for R. A. ± 0.15 arc sec, and for Dec a value varying between ±0.12 arc sec at $\delta = +40°$ and ±0.20 arc sec at $\delta = +40°$ and ±0.20 arc sec at $\delta = +77°$ and +4°. (auth)

12828 INTERFEROMETER OBSERVATIONS OF W3 (OH) AT 2.695 GHz AND 8.085 GHz. Wink, J. E. (Max-Planck-Institut fuer Radioastronomie, Bonn); Altenhoff, W. J.; Webster, W. J. Jr. Astron. Astrophys.; 22: No. 2, 251-5(Jan 1973).

Observations made at 2.695 GHz and 8.085 GHz with the NRAO interferometer show two continuum sources. At 8.085 GHz a half power width (HPW) of 1.5′′ was measured for the previously known continuum source. The continuum spectrum of this source and its connection with the OH sources in the area are discussed. (auth)

12829 CIRCULAR POLARIZATION STUDIES OF SELECTED COMPACT SOURCES AT 3240 MHz. Seaquist, E. R. (Univ. of Toronto, Richmond Hill, Ont.). Astron. Astrophys.; 22: No. 2, 299-308(Jan 1973).

Circular polarization observations of six compact radio sources at 3240 MHz over an extended period of time are summarized. The sources observed (PKS 1127-14, BL Lac, CTA 102, 3 C 138, NRAO 140, DA 344) were selected from an original survey (Seaquist, 1969) and were chosen because they exhibited evidence in this survey for circular polarization, and in some cases for variable circular polarization. The observations reveal evidence for variable circular polarization in PKS 1127-14, BL Lac, and CTA 102, and for possible circular polarization in 3 C 138 and NRAO 140. The results are compared with those of other observers at different frequencies. The agreement is good in the case of PKS 1127-14, but poor in the case of the other objects. The results and the comparison with other observers are discussed briefly in terms of synchrotron radiation theory, and it is concluded that the observations are consistent with synchrotron radiation, but that in at least one case (BL Lac) large anisotropies are required in the pitch angle distribution of the radiating electrons. (auth)

12830 SCORPIUS X-1 AS AN OLD NOVA. Shore, S. N.; Gebel, W. L. (State Univ. of New York, Stony Brook). Astrophys. J.; 179: No. 1, 257-61(1 Jan 1973).

An old-nova model is adopted to derive physical parameters for Sco X-1. The model consists of a standing shock, the source of the x-ray continuum, which is formed by mass accretion at the surface of a white dwarf. The source of the matter is taken to be a red companion which fills its Roche lobe. A mass accretion rate of 10^{-8} $M_\odot$ per year is found. Assuming a temperature of 5×10^{7}°K, an electron density of 10^{17} cm^{-3} is obtained for the shock. An optically thick envelope is assumed to fill the equipotential surface of the white dwarf. The observed optical depths are used to derive a temperature of 3.0×10^{4}°K for the region. The radius of the red companion is computed to be 2 $R_\odot$ and an upper limit is set to its temperature at 2.5×10^{3}°K. The possible origin of the radio sources associated with Sco X-1 is also considered. (auth)

12831 OBSERVATIONS TO TAURUS X-1 BY THE 1 TO 60-keV X-RAY DETECTOR ON THE OSO-7. Clark, G. W.; Bradt, H. V.; Lewin, W. H. G.; (and others) (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 179: No. 1, 263-8(1 Jan 1973).

The 1 to 60-keV x-ray detector on the OSO-7 satellite is described, and a measurement of the x-ray spectrum of the Crab Nebula is reported. (auth)

12832 LONG-TERM VARIATIONS OF TOTAL AND POLARIZED FLUXES, ABSOLUTE ENERGY DISTRIBUTION, AND LINE STRENGTH OF BL LACERTAE AND FOUR QUASI-STELLAR SOURCES. Visvanathan, N. (Harvard Coll. Observatory, Cambridge, MA). Astrophys. J.; 179: No. 1, 1-20(1 Jan 1973).

Observations of blue magnitude, polarization, wavelength dependence of polarization, absolute energy distribution of the continuum, and the strength of emission lines were obtained simultaneously for the variable QSSs 3C 279, 3C 345, 3C 446, 3C 454.3, and the object BL Lacertae on several occasions during the period 1967–1970. The continuum was linearly polarized in all these objects during outburst and nonoutburst periods and also when the objects reached minimum brightness. Whenever the total flux increased, an increase in polarized flux was observed. The position angle of the electric vector changed during the burst. The ratio between the polarized flux and the total flux does not exceed the value of about 0.16. This low value is interpreted as being due to the resultant polarization caused by several active spots in the continuum emitting-region. The absolute energy distributions of the continua both in active and quiet periods show that a power-law representation of the continuum is valid. This fact and the finding that the polarization is independent of wavelength support the view that the radiation in these objects in the observed frequency range is of synchrotron origin in both active and quiet periods. Variations in the spectral index of the continua were observed, but no simple relationship between color and brightness was found. During the period of the observations the absolute intensity of the emission line Mg II in 3C 345 and 3C 454.3, and the C IV line in 3C 446, remained constant within 10 to 20%. The emission line Mg II in 3C 345 was unpolarized, indicating that the regions from which the emission line originates are randomly arranged. (auth)

12833 POLARIZATION OF RADIO SOURCES. IV. THE COMPACT SOURCE PKS 2134 + 004. Pacholczyk, A. G.; Swihart, T. L. (Univ. of Arizona, Tucson). Astrophys. J.; 179: No. 1, 21-8(1 Jan 1973).

Data on flux, circular polarization, linear polarization, and angular size for apparently simple nonvariable compact radio sources are brought together and analyzed in an attempt to restrict the range of possible models. Three such sources are investigated: PKS 2134 + 004, PKS 0237 – 23, and PKS 1148 – 00. All three are found to show strong evidence of a significantly nonhomogeneous structure. A plausible model is one in which the main part of the flux is produced in a core, while the linear polarization originates in a shell that is thin both optically and to Faraday rotation. Part of the observed circular polarization may be produced by Faraday pulsation from the relativistic electrons in the sources. (auth)

12834 EVIDENCE FOR EJECTION OF RADIO SOURCES FROM SUPERNOVA REMNANTS. Mathewson, D. S. (Australian National Univ., Canberra); Clarke, J. N. Astrophys. J.; 179: No. 1, 89-95(1 Jan 1973).

Evidence is presented that the radio source 0525 – 66.0 has been ejected from N49, a supernova remnant in the Large Magellanic Cloud, to a distance of at least 13 times the radius of the shell of N49. A similar process is thought to have occurred in N11 L, another supernova remnant in the Large Cloud. (auth)

12835 ASTROPHYSICAL MASERS. II. POLARIZATION PROPERTIES. Goldreich, Peter (California Inst. of Tech., Pasadena); Keeley, D. A.; Kwan, J. Y. Astrophys. J.; 179: No. 1, 111-34(1 Jan 1973).

The equations governing the transfer of polarized radiation in astrophysical masers are derived. It is found that the magnetic field and the plasma in maser sources play a central role in determining the polarization of the emitted radiation. The character of the polarization depends upon the relative sizes of the decay constant of the maser levels, Γ; the stimulated-emission rate, R;

the Zeeman splitting, $g\Omega$; and the bandwidth of the amplified radiation, $\Delta\omega$. Unsaturated masers ($R < \Gamma$) emit unpolarized radiation unless $g\Omega \gtrsim \Delta\omega$. For $g\Omega \gtrsim \Delta\omega$ they amplify the Zeeman pattern if the Faraday rotation per gain length in the source is small. If the Faraday rotation per gain length is large, then the σ components of the Zeeman pattern are 100% circularly polarized and the π component is unpolarized. Saturated masers ($R > \Gamma$) emit unpolarized radiation unless $g\Omega \gtrsim (R\Gamma)^{1/2}$. If the Faraday rotation across the region of saturated amplification is small, the emitted radiation is partially linearly polarized for $(R\Gamma)^{1/2} < g\Omega \ll \Delta\omega$ whereas for $g\Omega \gtrsim \Delta\omega$ it is just the amplified Zeeman pattern. If the Faraday rotation across the saturated region is large, all linear polarization is destroyed. For $g\Omega > \Delta\omega$, the σ components of the Zeeman pattern are again 100% circularly polarized. (auth)

12836 ANGULAR SIZE OF THE QUASAR 3C 298 AND OF THE SCINTILLATING COMPONENT OF 3C 273 AT 60 MHz. Panadzhyan, V. G. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 6: No. 1, 76(1970).

Translated from Astrofizika; 6: No. 1, 165-7(1970).

The angular size of the quasar 3C 298 and the scintillating component of 3C 273 were estimated at 60 mHz by considering the shift of the mean quasi-periods of the scintillations. (WDM)

12837 NEUTRON STARS OF LOW MASS. Vartanyan, Yu. L. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 6: No. 1, 77-8(1970).

Translated from Astrofizika- 6: No. 1, 167-70(1970).

The pulsars CP 1919 and AP 2315 + 28 have a main period $\approx$1 sec and a subperiod $\approx 10^{-2}$ sec. If the main period is associated with the rotation of a magnetic neutron star and the subperiod with the radial pulsations, then these radial oscillations can be executed only by neutron stars of low mass (0.1 to 0.2 $M_\odot$). The cooling time and interior parameters of such hot neutron stars are considered. (WDM)

12838 GAMMA AND RADIO EMISSION OF NEUTRON STARS IN THE STATE OF ACCRETION. Shvartsman, V. F. (State Astronomical Inst., Moscow). Astrophysics (Engl. Transl.); 6: No. 1, 56-62(1970).

Translated from Astrofizika; 6: No. 1, 123-34(1970).

The accretion of gas by a neutron star should be accompanied by high-intensity gamma-ray emission due to the generation of neutral and charged pions, and nuclear and thermonuclear reactions in the stellar atmosphere. By recording the gamma-ray spectra, it is possible to distinguish these objects from other sources and hence determine the magnitude of the gravitational potential on the surface of a neutron star. Eighteen sources are suggested for which the corresponding luminosities may be detectable in the course of experiments planned for 1971. The emission of gamma-ray photons is accompanied by the injection into cosmic space of relativistic electrons and positrons which radiate in the magnetic fields. This radiation can be observed with modern radio and optical devices. The radio luminosity of Sco X-1 is capable of this interpretation. (auth)

12839 EXCITATION MECHANISM FOR THE FILAMENTS IN THE CRAB NEBULA. Apparao, K. M. V. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 5: No. 13, 877-8 (25 Nov 1972).

It is suggested that the low-frequency radiation emitted by NP 0532 supplies energy for the excitation of the filaments of the Crab Nebula. (WDM)

12840 ARE THE CHEMICAL ABUNDANCES IN THE COSMIC MASERS ABNORMAL? Strelnitskii, V. S.; Sunyaev, R. A.; Varshalovich, D. A. Comments astrophys. Space Phys.; 4: No. 5, 155-9(1972).

The analysis of the physical processes leading to the phenomenon of the cosmic OH and H_2O masers is made under the assumption of normal chemical abundances in the amplifying medium: like those in the stellar atmospheres and gaseous nebulae. This point of view follows from the widespread interpretation of the maser sources in H II regions as protostars. If the amplification region is in the outer layers of a protostar itself, there is no serious ground for suspecting substantial anomalies of abundances in this region. It is shown that the observational data are easier explained, if one assumes a great deficiency of hydrogen in the maser sources. (WDM)

12841 REMARKS ON A NEW METHOD FOR ASTRONOMICAL OBSERVATION BY B. KAPLAN. Burman, R. (Univ. of Western Australia, Canberra). Lett. Nuovo Cim.; 5: No. 16, 1054-5(16 Dec 1972).

Recently Kaplan (1972) suggested that it might be possible to detect electromagnetic radiation generated by pulsars with frequencies near their rotation or pulsation frequencies. He pointed out that the Earth's ionosphere is likely to have an effect on these waves. The effects of the plasma surrounding the pulsar and of the interstellar plasma are briefly considered. (WDM)

12842 SPECTRA OF SOURCES IN THE ±4° DECLINATION ZONE OF THE PARKES 2700 MHz SURVEY. I. SPECTRA OF INDIVIDUAL SOURCES. Wall, J. V. (CSIRO, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 24, 1-47(Oct 1972).

A series of observations to determine the spectra of sources in the ±4° declination zone of the Parkes 2700 MHz survey is described. The observations yielded flux densities for 370 sources at 5009 MHz, 300 sources at 1403 and 468 MHz, and 450 sources at 635 MHz, while additional flux densities for many of the sources were obtained from published measurements from other observatories. Spectral data are also tabulated for some of the sources found in the Parkes 2700 MHz deep surveys of selected regions. The spectra of a number of the sources are illustrated and discussed. Several of the sources appear to be variable at high frequencies. (auth)

12843 SPECTRA OF SOURCES IN THE ±4° DECLINATION ZONE OF THE PARKES 2700 MHz SURVEY. II. STATISTICAL ANALYSIS. Wall, J. V. (CSIRO, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 24, 49-63(Oct 1972).

An analysis is presented of the spectral data for sources in the +4° to −4° declination zone of the Parkes 2700 MHz catalogue. The proportions of the different types of radio spectra in the sample are derived. Spectral differences between quasi-stellar objects and radio galaxies are discussed and the results are used to estimate the proportion of the unidentified sources which belong to each class. The existence of a correlation between spectral index and flux density is established for sources in the present sample and implications of this result for source counts at different frequencies are discussed. (auth)

12844 CLASSIFICATION OF SUPERNOVA REMNANTS AND H II REGIONS FROM THEIR RECOMBINATION LINE EMISSION. Dickel, J. R. (Univ. of Illinois, Urbana); Milne, D. K. Aust. J. Phys.; 25: No. 5, 539-44(Oct 1972).

H109α recombination line observations were used in an attempt to classify 46 galactic radio sources as either supernova remnants or H II regions. Long integrations at the H109α line frequency on two well-known supernova remnants (IC443 and 3C391) provided improved upper limits on the line emission from these objects. From these results the electron temperature in IC443 was estimated to be in excess of 1.6×10^4°K. (auth)

12845 OBSERVATIONS OF THE RADIO SOURCE PKS0123-01 AT 5000, 408, AND 80 MHz. Schilizzi, R. T. (Univ. of Sydney); Lockhart, I. A.; Wall, J. V. Aust. J. Phys.; 25: No. 5, 545-58(Oct 1972).

Observations of PKS0123−01 (3C40) were made at 5000, 408, and 80 MHz with telescopes of comparable beamwidth. The value of the spectral index for the frequency intervals 5000 to 408 and 408 to 80 MHz was calculated for a grid of points covering the source spaced at approximately half-beamwidth intervals. For both frequency intervals the spectrum of emission was found to be significantly steeper for the regions of the source furthest from the associated galaxies NGC545−547 than for the regions nearest the galaxies. Some implications of this result are discussed. The age and energy requirements of the source were also estimated. (auth)

12846 POSITIONS AND SOME IDENTIFICATIONS FOR 111 SOURCES OF ABOUT 1 FLUX UNIT AT 408 MHz. Hoskins, D. G. (Univ. of Sydney); Murdoch, H. S.; Hazard, C.; Jauncey, D. L. Aust. J. Phys.; 25: No. 5, 559-79(Oct 1972).

Radio positions with an accuracy of ~5 sec arc were measured for a sample of 111 sources that have flux densities in the range 0.6 to 5.5 f.u. at 408 MHz but which are not listed in the 4C catalogue. An investigation of the random background rates for both galaxies and BSO's shows that the expected chance identification rate is small for galaxies brighter than 19m and for BSO's to the plate limit. A comparison of optical and radio positions shows that radio−optical separations of up to 15 sec arc are common for galaxies of 18m or brighter, but rare for BSO's. The identification content, corrected for chance associations, is 16% BSO's and 20% galaxies. (auth)

12847 AMPLITUDE-TIME AND POLARIZATION CHARACTERISTICS OF SUBPULSES OF PULSAR SR 1133. Alekseev, Yu. I.; Vitkevich, V. V.; Malofeev, V. M. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 2, 307-9 (11 Jul 1972). (In Russian).

Two sub-pulses of pulsar SR 1133 were compared on the basis of their amplitude−time and polarization characteristics, employing the 1000-foot Arecibo radio telescope at frequencies of 111, 111.5, and 112, 318, and 606 MHz. The temporal variations in intensity of one class of sub-pulse was quasi-periodic. The sub-pulses possessed a high degree of linear polarization, as measured within

the limits, 0.4 to 0.85. The extent of circular polarization reached the value of 0.5. (KSW)

12848 EXTENDED X-RAY AND RADIO OBSERVATIONS OF SCORPIUS X-1. Canizares, C. R. (Massachusetts Inst. of Tech., Cambridge); Clark, G. W.; Lewin, W. H. G.; (and others). Astrophys. J.; 179: No. 1, L1-5(1 Jan 1973).

A 23-day observation reveals temporal variations at energies of 3 to 10 keV similar to those found in previous optical data. However, there is no evidence of more than one preferred intensity level or of an intensity threshold for flares. X-ray periodicities containing ≥5% of the mean quiescent-period intensity with periods of from 6 minutes to 4 hours are ruled out. The x-ray intensity is strongly correlated with hardness but is not correlated with radio data collected over eight days. (auth)

12849 FREQUENCY DEPENDENCE OF PULSAR POLARIZATION. Manchester, R. N.; Taylor, J. H.; Huguenin, G. R. (Univ. of Massachusetts, Amherst). Astrophys. J.; 179: No. 1, L7-10 (1 Jan 1973).

Observations show that the fractional linear polarization of integrated pulsar profiles is constant up to some critical frequency, but decreases with increasing frequency above this point. Above the critical frequency the polarization is, in most cases, approximately inversely proportional to frequency. (auth)

12850 OBSERVATIONS OF THE NEUTRAL-HYDROGEN ABSORPTION SPECTRUM OF CYGNUS X-3. Chu, K. W.; Bieging, J. H. (California Inst. of Tech., Pasadena). Astrophys. J.; 179: No. 1, L21-3(1 Jan 1973).

Interferometric observations of the neutral-hydrogen absorption spectrum of Cygnus X-3 were made. The radio source is more than 10.4 kpc from the Sun, and the columnar density of neutral hydrogen along the line of sight is at least 1.7×10^{20} T, cm^{-2}. (auth)

12851 OPTICAL VARIATIONS OF OJ 287, ON 231, AND OQ 208. Craine, E. R.; Warner, J. W. (Ohio State Univ., Columbus). Astrophys. J.; 179: No. 1, L53-6(1 Jan 1973).

Optical observations of three Ohio radio sources made during the early part of 1972 are presented. Old plate collections yielded a 20-year period of observations of OJ 287, with a possible indication of "intraday" variations; OQ 208 is now suspected to be a long-term optical variable. (auth)

12852 ABSORPTION SPECTRA OF QUASARS. McKee, C. F.; Tarter, C. B.; Weisheit, J. C. (Univ. of California, Livermore). Astrophys. Lett.; 13: No. 1, 13-18(Jan 1973).

The ionization equilibrium of the gas producing the absorption lines in quasar spectra is studied in detail. Lower limits are placed on the density of the absorbing gas, and it is shown that in some cases this gas must be at large distances from the quasar. The results are applied to 4C 05.34. (auth)

12853 INTERNAL FARADAY ROTATION OF CYGNUS A. Mitton, Simon (Inst. of Astronomy, Cambridge, Eng.). Astrophys. Lett.; 13: No. 1, 19-22(Jan 1973).

It is shown that the distribution of rotation measures across Cygnus A correlates with the radio source structure. It is argued that the anomalous rotation is intrinsic to the source. (auth)

12854 LAMBDA-DOUBLING OF THE ^{17}OH MOLECULE AT MICROWAVE FREQUENCIES. Valtz, I. E.; Soglasnova, V. A. (Space Research Inst., Moscow). Astrophys. Lett.; 13: No. 1, 23-24(Jan 1973).

The microwave frequencies of the most intense main lines of the molecule ^{17}OH are presented. (auth)

12855 OPTICAL IDENTIFICATION CRITERIA FOR BINARY X-RAY SOURCES. Lea, S. M. (Univ. of California, Berkeley); Margon, Bruce. Astrophys. Lett.; 13: No. 1, 33-37(Jan 1973).

There is now evidence that several galactic x-ray sources are members of binary systems. Although one member of each system is believed to be highly evolved, probably a neutron star or a black hole, the orbits show no observable ellipticity. Formation of neutron stars by conventional supernovae always produces eccentric orbits. It is proposed that the orbits are circularized following the supernova, by tidal forces. If this theory is correct, then the rotational period of the primary should be equal to the orbital period of the binary system. It is suggested that spectra of the optical candidates for these sources be examined for evidence of rapid rotation. (auth)

12856 OBSERVATIONS OF DARK CLOUDS IN IC 1795 (W3) IN THE FORMALDEHYDE LINE AT 4830 MHz. Minn, Y. K. (Max-Planck-Institut fuer Radioastronomie, Bonn); Greenberg, J. M. Astrophys. Lett.; 13: No. 1, 39-44(Jan 1973).

A survey of H_2CO absorption in dark clouds in IC 1795 (W3) shows that the material in the direction of W3 can be distinctly separated into three groups: the first immediately surrounding W3, has a uniform velocity of about −41 km/sec; the second, associated with the W3(OH) source has a velocity of about −49 km/sec; the third, has a velocity of about −20 km/sec and may be associated with an interarm spur in the foreground. (auth)

12857 BRIGHT INFRARED SOURCES IN M17. Kleinmann, D. E. (Smithsonian Astrophysical Observatory, Cambridge, MA). Astrophys. Lett.; 13: No. 1, 49-54(Jan 1973).

Observations of four bright infrared sources discovered in M17 are detailed. Two point sources bright at 2.2 μm are identified with the star BD −16°4816 and with a star 1.6s E and 77'' N of BD −16°4816; the possible role of these stars in the excitation of the nebula is considered. Two extended, optically thin sources were mapped at 10 μm with a 21-arc sec beam, and 5- to 25-μm photometry of their central regions was obtained. Each is ~100 arc sec in diameter, with 10- to 22-μm color temperatures of 215 K and 10-μm brightness temperatures of ~95 K. The observations indicate that the 10-μm radiation of these extended sources is thermal emission from dust grains and that these grains are distributed similarly to the ionized gas. (auth)

12858 LARGE-SCALE LINE SPLITTING IN FIVE GALACTIC H II REGIONS. Dopita, M. A.; Gibbons, A. H.; Meaburn, J.; Taylor, K. (Univ. of Manchester, Eng.). Astrophys. Lett.; 13: No. 1, 55-59(Jan 1973).

Many observations of singly and multiply split [O III] and [N II] lines from large areas of five galactic H II regions are presented. These were all made with a variety of single and double etalon Fabry–Perot monochromators. Explanations are sought for these and other unusual motions in H II regions and their similarity to spectral features in some planetary nebulae are pointed out. (auth)

12859 ACCELERATION OF CHARGED PARTICLES IN THE ELECTROMAGNETIC FIELD OF PULSARS. Fischer, W. (Schweizerisches Institut fuer Nuklearforschung, Zurich); Straumann, N. Helv. Phys. Acta; 45: 1089-1093(1972).

The acceleration of charged particles in the wave zone of the electromagnetic field of pulsars was studied numerically and compared with previous approximate analytic solutions. (auth)

12860 UBV COLORS OF SCO X-1 AT THE TIME OF AN X-RAY OBSERVATION. Osborn, W. (Univ. de Los Andes, Merida, Venezuela). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 393-4(Nov 1972).

The UBV colors of Sco X-1 measured during a simultaneous x-ray observation are presented. (auth)

Solar Phenomena

Refer also to abstracts 11997, 12694, 13173, and 13780.

12861 (AD–743921) CONTINUOUS MONITORING OF SOLAR X-RAYS. PART I. DEVELOPMENT OF A PROGRAM FOR AWS USE WITH THE VELA SATELLITE DATA. Manson, J. E.; Bench, P. M. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 1 Mar 1972. 39p. (AFCRL-ERP-389; AFCRL-72-140). NTIS.

A computer program for the rapid reduction of the Vela satellite x-ray data was developed for use at the Air Force Global Weather Central computer facility of the Air Weather Service. The physical reasoning and mathematical analysis underlying this program are presented. Sufficient detail is included to allow an understanding of the source program listing. As originally set up, this program delivers a two-temperature bremsstrahlung equation approximation to the solar x-ray flux for each 32 seconds of data. From this approximation, sets of values of 0.5 to 3 A flux and 1 to 8 A flux are stored, and periodically searched to detect possible x-ray flares. For each flare which is detected, parameters such as start time, maximum time, and total energy are stored for recall on demand. (auth)

12862 (AD–744952) 2-CM RADIOMETER DATA CATALOG, 29 JUNE 1967–10 MARCH 1970. Progress Report for 1971. Shawhan, S. D.; Denning, G. F.; Sentman, D. D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Oct 1971. Contract N00014-68-A-0196-0003. 36p. NTIS.

A 2-cm radiometer (15,375 MHz) has been operated by the University of Iowa, Department of Physics and Astronomy between June 27, 1967 and March 1970 at the North Liberty Radio Observatory. The system operation and calibration procedure and the data storage and retrieval methods are briefly described. References are given to more complete descriptions. A data catalog is presented which lists the date, universal start and end times, quality of data records, data record type, and an indication of activity level observable on each data record. (auth)

12863 (N-72-24833) STUDY OF ENERGETIC SOLAR PARTICLE EVENTS OF 18 NOVEMBER 1968, 25 FEBRUARY 1969, AND 30 MARCH 1969. Venkatarangan, P.; Venkatesan, D.; Van-Allen, J. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). 1971. 61p. (NASA-CR-126661). NTIS.

The solar particle events of November 18, 1968, February 25, 1969, and March 30, 1969, were studied using data from the detector system aboard the lunar orbiting satellite Explorer 35. Protons, alpha particles, and $Z \geq 3$ were registered in the solid-state detector of the system. Interplanetary propagation, particle anisotropy, and the intensity ratios of protons to alpha particles and of alpha particles to C, N, and O nuclei above a common specific energy of 0.5 MeV/N were studied. Diffusion coefficients and decay constants for the three events are given, as well as magnitudes and directions of anisotropies. (auth)

12864 (TRITA-EPP-72-18) COMET: METEOR STREAM COMPLEX. Mendis, D. A. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Aug 1972. 25p. Dep. NTIS (U. S. Sales Only).

It is suggested that the genetic relationship between comets and meteor streams may well be a reciprocal one, contrary to popular belief. This should be an important consideration in any attempt at accounting for the observed population of short-period comets. (auth)

12865 HEATING AND DECAY OF SUNSPOTS. Ponomarenko, Yu. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 460-8(1972).

Translated from Astron. Zh.; 49: No. 3, 568-78(1972).

It is shown that the suppression of supergranular motion in a sunspot will result in heating of its invisible lower portion. The energy of heating is equal to the "lost" radiant energy of the spot. The heating of the spot is considered to lead to renewal of the supergranular motion, causing the spot to decay and producing daily fluctuations in its magnetic field. (auth)

12866 PROPERTIES OF DIFFERENT GROUPS OF TYPE IV SOLAR RADIO BURSTS. Akin'yan, S. T. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 469-75(1972).

Translated from Astron. Zh.; 49: No. 3, 579-87(1972).

From radio observations of the Sun at fixed frequencies, the three principal groups of Type IV bursts are found to have the following properties: 1) a shift in the commencement time at different frequencies within a single burst component; 2) a time shift between components belonging to the same group; 3) a time lag of Type IV bursts relative to the corresponding Type II bursts. These properties suggest different conditions for the production of the phenomena observed in the various groups. (auth)

12867 BEHAVIOR OF CARBON MONOXIDE IN THE UPPER PHOTOSPHERE. Polonskii, V. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 543-5 (1972).

Translated from Astron. Zh.; 49: No. 3, 663-6(1972).

Spectrograms of the solar photosphere and faculae were obtained. Equivalent widths were determined for 25 first-harmonic CO lines at $\lambda\lambda$ 2.3 to 2.4 μ. In low-temperature plasma the CO molecule is highly sensitive to small temperature fluctuations; near 5000°K a temperature rise of ≈1% will entail dissociation ≈10% of all the CO molecules. (auth)

12868 INVESTIGATION OF THE CHROMOSPHERE IN THE D_3 HELIUM LINE AT THE ECLIPSE OF SEPTEMBER 22, 1968. Belkina, I. L.; Dyatel, N. P. (Univ., Kharkov). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 476-9(1972).

Translated from Astron. Zh.; 49: No. 3, 588-94(1972).

Results are reported of observations of the D_3 He line in active and quiet regions on the Sun during the 1968 total eclipse. The height profile of the surface brightness was determined for the lower and middle chromosphere. A secondary brightness maximum at a height of ≈1500 km was found in some of the regions measured. (auth)

12869 CHARACTERISTICS OF INTERPLANETARY ELECTRON IRREGULARITIES ACCORDING TO OBSERVATIONS IN 1967-1969. Vitkevich, V. V.; Vlasov, V. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 480-9(1972).

Translated from Astron. Zh.; 49: No. 3, 595-606(1972).

The parameters of electron irregularities in the interplanetary medium at distances of 0.35 to 1.2 AU from the Sun have been determined from scintillation observations with three spaced radio telescopes. The drift velocity of the irregularities is smaller (250 to 300 km/sec) at high heliocentric latitudes than in the equatorial regions (≈450 km/sec). After correction for the effects of the size, shape, and orientation of the scintillating radio source on the characteristics of the observed diffraction pattern, the size of the irregularities is found to increase with distance from the Sun. They are elongated in the radial direction by 1.9 : 1, on the average, independently of their distance from the Sun. A linear dependence of the velocity of the irregularities and the scintillation index upon the Wolf number is found. For irregularities at high heliocentric latitudes the correlation delay in the velocity and scintillation index with respect to the Wolf number exceeds the delay in the equatorial regions, and agrees closely with Parker's model for irregularities of the average velocities observed. (auth)

12870 CORRELATION ANALYSIS OF THE CONTINUUM RADIO EMISSION OF NOISE STORMS. Gnezdilov, A. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 546-8 (1972).

Translated from Astron. Zh.; 49: No. 3, 666-9(1972).

A correlation spectrum analysis was made of the fluctuations in the radio emission of two noise storms at 111, 202, 224, and 287 MHz and of two other storms at 202 MHz only. The radiation power spectra tended to remain unchanged with time while the continuum flux varied. The power spectra of all four storms exhibited four or five comparable maxima, indicating that quasi-periodic oscillations were present with mean periods of 9.8, 7.3, 5.9, 5.2, and 3.8 min. For one storm a shift of oscillations from high to low frequencies was observed in the range 111 to 287 MHz following a Type III burst recorded at the same frequencies. A discussion of the results is given. (auth)

12871 PHOTOMETRIC MODEL OF THE ZODIACAL LIGHT. Roach, F. E. (Rutgers-The State Univ., Newark, NJ). Astron. J.; 77: No. 10, 887-92(Dec 1972).

An intercomparison of published photometric investigations of the zodiacal light and gegenschein was made, leading to a compilation of brightnesses over the entire sky in a reseau with 5-deg intervals. The results are given in absolute units. Several graphical representations illustrate the compilation. (auth)

12872 SOME COMMENTS ABOUT THE ^{176}Lu-^{176}Hf PAIR. Arnould, M. (Univ. Libre, Brussels). Astron. Astrophys.; 22: No. 2, 311-15(Jan 1973).

Some comments are presented about the possible interest of a more detailed study of the $^{176}Lu - ^{176}Hf$ pair, which possesses the unique feature of being composed of two s-only isobars. In particular, that pair could be used to determine with good confidence the relative solar system Hf and Zr abundances if the s-process production ratio R of ^{176}Hf and ^{176}Lu was known with satisfactory precision. A comparison between the results of such an approach and new determinations of Hf and Zr in meteorites could also possibly provide a test regarding the qualification of the C1 and/or C2 chondrites to closely approximate the condensable fraction of the primordial solar system matter. Moreover, if R and n(Lu)/n(Hf) were measured with good precision, it would be possible to use the $^{176}Lu - ^{176}Hf$ pair as a nucleochronometer for the s-process. (auth)

12873 HEATING OF THE SOLAR CORONA. I. OBSERVATION OF ION ENERGIES IN THE TRANSITION ZONE. Boland, B. C.; Engstrom, S. F. T.; Jones, B. B.; Wilson, R. (Culham Lab., Abingdon, Eng.). Astron. Astrophys.; 22: No. 2, 161-9 (Jan 1973).

A high-resolution solar spectrum was obtained over the range 1200 to 2200 Å using an echelle spectrograph launched in a Sun-pointing Skylark rocket. Profiles of emission lines were recorded due to the ions Si II, C II, Si III, and C IV, embracing the temperature range 10^4 to 10^5 °K. The measured Doppler widths correspond to "temperatures" very much in excess of the electron temperatures deduced from ionization balance theory. Since the ion–electron relaxation times are very short, this clearly demonstrates the presence of a nonthermal energy component in the particular region of the transition zone. On the proposition that this represents the actual energy responsible for heating the corona and that this is propagating in an acoustic mode, an energy flux of 5×10^5 erg cm^{-2} s^{-1} is derived. This is in agreement with estimates of the total energy required to produce the corona and provides the most definite available evidence in support of the proposition. (auth)

12874 GYRO SYNCHROTRON RADIATION FROM THERMAL PLASMAS. Shukla, P. K. (Umeaa Univ., Sweden); Singh, K. P. Phys. Scr.; 5: No. 4-5, 217-18(1972).

The gyro-synchrotron radiation from the solar coronal plasma is investigated with special regard to temperature effects. The influence of nonzero temperature is to enhance the radiated synchrotron power from the solar coronal plasma. We also observe that fast test charges radiate more power than slow charges. (auth)

12875 DAMPING OF THE NaD LINES IN THE SOLAR SPECTRUM BY ATOMIC HYDROGEN. Blackwell, D. E.; Kirby, J. H.; Smith, G. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc.; 160: No. 2, 189-96(1972).

A brief discussion is given of the nature of the damping processes in the atmospheres of cooler stars, followed by a calculation of the absorption in the wings of the Na D lines in the solar spectrum using damping constants recently calculated by Lewis, McNamara, and Michels (Phys. Rev. A.; 3: 1939 (1971) and Sol. Phys.; 23: 287 (1972)). The agreement between theory and observation is discussed critically. (auth)

12876 WHY DOES THE SUN SOMETIMES LOOK LIKE A MAGNETIC MONOPOLE. Wilcox, J. M. (Stanford Univ., CA). Comments Astrophys. Space Phys.; 4: No. 5, 141-7 (1972).

The puzzling situation existing in the observations of the solar magnetic field during the first part of 1965 in which for three or four consecutive months the observations obtained with solar magnetographs showed that the solar field was predominantly directed out of the Sun at all solar latitudes is considered. (WDM)

12877 ISOTOPES OF RUBIDIUM IN THE SUN. Hauge, Oeivind (Univ. of Oslo). Solar Phys.; 26: No. 2, 263-75 (Oct 1972).

The Rb I resonance lines at 7800 and 7947 Å in the photospheric spectrum of the Sun have profiles which are influenced by the isotopic composition of rubidium. High-resolution spectra obtained with the McMath Solar Telescope at Kitt Peak National Observatory were studied. A solar isotopic composition $^{87}Rb/Rb = 0.27 \pm 0.04$ was found using spectra of the Rb I line at 7800 Å obtained with the spectrograph slit in positions close to the solar limb. The other Rb I line was abandoned since it was seriously blended with a water vapor line and some additional faint unknown lines. (auth)

12878 SEARCH FOR THE SOLAR ^{87}Sr CONTENT AND THE SOLAR RB/SR RATIO. Hauge, Oeivind (Univ. of Oslo). Solar Phys.; 26: No. 2, 276-82(Oct 1972).

Some energy levels of ^{87}Sr show hyperfine splitting which broadens strontium lines in the solar spectrum. By analysis of two faint photospheric Sr I lines of Multiplet No. 3 an upper limit of the relative ^{87}Sr content ($^{87}Sr/Sr$) of $1/4$ was found. The terrestrial value is 0.07 to 0.075. The solar abundance of strontium found from the two lines was log $\epsilon_{Sr} = 2.90$ in the log $\epsilon_H = 12.00$ scale. Using the solar rubidium abundance recently determined by the author (Hauge, 1972), one obtains $\epsilon_{Rb}/\epsilon_{Sr} = 0.5 \pm 0.1$. This value is larger than found even in chondrites showing high rubidium content. (auth)

12879 LARGE-SCALE PHOTOSPHERIC MAGNETIC FIELD: THE DIFFUSION OF ACTIVE REGION FIELDS. Schatten, K. h. (Goddard Space Flight Center, Greenbelt, MD); Leighton, R. B.; Howard, Robert; Wilcox, J. M. Solar Phys.; 26: No. 2, 283-9(Oct 1972).

The large-scale photospheric magnetic field was computed by allowing observed active region fields to diffuse and to be sheared by differential rotation in accordance with the Leighton (1969) magnetokinematic model of the solar cycle. The differential rotation of the computed field patterns as determined by autocorrelation curves was similar to that of the observed photospheric field, and poleward of 20° latitude both were significantly different from the differential rotation of the long-lived sunspots (Newton and Nunn, 1951) used as an input into the computations. (auth)

12880 MECHANISM FOR THE EXPLODING GRANULE PHENOMENON. Musman, Steven (Sacramento Peak Observatory, Sunspot, NM). Solar Phys.; 26: No. 2, 290-8(Oct 1972).

It is suggested that the exploding granule phenomenon is a consequence of the observed internal granular motions and the conservation of angular momentum. When a granule rising from the convection zone penetrates into the overlying stable region it is stretched out horizontally. Conservation of angular momentum in the internal motions changes its form into a vortex ring. A time sequence of photographs showing an exploding solar granule is described. The proposed mechanism is illustrated by a laboratory simulation and a numerical calculation. (auth)

12881 TIME-AVERAGED SPECTROHELIOGRAMS. Chapman, G. A. (San Fernando Observatory, CA). Solar Phys.; 26: No. 2, 299-304(Oct 1972).

The great improvement in signal-to-noise as a result of time-averaging a sequence of λ6103-core spectroheliograms is shown. It is suggested that such a technique should greatly enhance the network seen on filtergrams made with the 3840 Å violet filter (Chapman, 1970). Finally, the evolution of a sunspot, observed with time-lapse spectroheliograms, is discussed. (auth)

12882 SUNSPOT STRUCTURE. Krat, V. A.; Karpinskii, V. N.; Pravdyuk, L. M. (Pulkova Observatory, Leningrad). Solar Phys.; 26: No. 2, 305-17(Oct 1972).

The fine structure of a sunspot was studied on a series of photographs obtained during the third flight of the Soviet Stratospheric Solar Station. The main results were as follows: (1) The micro-photometer tracings on the frames show extremely high Rayleigh resolution of small elements, the smallest distances being near to the theoretical limit. The half-widths of the brighter elements are given. The corrected brightness of umbral dots has large dispersion. (2) The dimensions of the smallest dots are equal to the diffraction image of bright points. So the real radii of these objects are smaller than 150 km, which is consistent with opaque models of sunspot umbra. (3) The penumbra and umbra structure (dark and bright objects) is in good agreement with the picture of magnetic field splitting in a system of magnetic ropes giving rise to the magnetic arcs in the chromosphere and corona. Only in the umbra are the large scale continuities met with. (auth)

12883 CORRECTION OF SOLAR OBSERVATIONS FOR STRAY LIGHT BY NUMERICAL INTEGRATION, WITH APPLICATION TO MERCURY'S DROP. Brahde, Rolf (Inst. of Theoretical Astrophysics, Olso). Solar Phys.; 26: No. 2, 318-34 (Oct 1972).

A numerical method for correction of stray light in solar observations was developed. In particular a regular sunspot, where the circular contours of penumbra and umbra are projected as ellipses, was studied. When a specified set of values for the stray light parameters is given, and also tentative values for the relative intensities of penumbra and umbra, the integration of stray light can be performed in any point. The results will be the observable intensity if the conditions were as given by these initial values. By means of limb observations the stray light parameters may be improved, and finally a variation of the penumbra and umbra intensities in the computation enables a determination of these quantities by comparison with observations. The method is tested on observations of the transit of Mercury, May 9, 1970. Calculation of isophotes with Mercury close to the limb shows the black drop phenomenon; which thus may be explained as an effect of stray light only. It is also shown that the Wilson effect on a sunspot cannot be produced by stray light alone. (auth)

12884 EQUATOR–POLE DIFFERENCES IN THE SOLAR CHROMOSPHERE FROM LYMAN-CONTINUUM DATA. Vernazza, J. E. (Harvard Coll. Observatory, Cambridge, MA); Noyes, R. W. Solar Phys.; 26: No. 2, 335-42(Oct 1972).

From the analysis of OSO-4 Lyman-continuum spectroheliograms, differences in the brightness and the color temperature between the poles and the equator were found. These differences are interpreted as resulting from a lower chromospheric density at the poles than at the equator. Two models, one for the poles and one for the equator, giving temperature and density as a function of height, explain the observations. The poles have a lower density and a smaller temperature gradient than the equator does. The differences begin in the middle chromosphere and increase toward the transition zone. (auth)

12885 CORONAL ABUNDANCE OF ELEMENTS AND A MODEL OF THE QUIET SUN FROM RADIO OBSERVATIONS. Chiuderi, Claudio; Drago, F. C.; Noci, Giancarlo (Arcetri Astrophysical Observatory, Florence). Solar Phys.; 26: No. 2, 343-53(Oct 1972).

It is shown that the combined use of radio observations of the quiet Sun and uv line intensities allows to compute the absolute coronal abundance of the elements. The abundances found by this method agree very well with the most recent determinations. A model of the transition region and corona in hydrostatic equilibrium is also presented. Similarities and differences with models based on uv observations are discussed. (auth)

12886 CORONAL HOLES. Altschuler, M. D. (National Center for Atmospheric Research, Boulder, CO); Trotter, D. E.; Orrall, F. Q. Solar Phys.; 26: No. 2, 354-65(Oct 1972).

Coronal holes are extensive regions of extremely low density in solar corona within 60° of latitude from the equator. (They are not to be confused with the well-known coronal cavities which surround quiescent prominences beneath helmet streamers.) Maps of the calculated current-free (potential) coronal magnetic field were superposed with maps of the coronal electron density for the period of November 1966, and it was found that coronal holes are generally characterized by weak and diverging magnetic field lines. The chromosphere underlying the holes is extremely quiet, being free of weak plages and filaments. The existence of coronal holes clearly has important implications for the energy balance in the transition region and the solar wind. (auth)

12887 EMISSION LINES OF HYDROGEN, HELIUM, AND IONIZED CALCIUM SEEN ON A CORONAL SPECTROGRAM OF

THE MARCH 7, 1970 ECLIPSE. Bappu, M. K. V.; Bhattacharyya, J. C.; Sivaraman, K. R. (Indian Inst. of Astrophysics, Kodaikanal). Solar Phys.; 26: No. 2, 366-9(Oct 1972).

Emission lines of the Balmer series, D_3 and H and K are reported present on a coronal spectrogram obtained at the March 7, 1970 eclipse. Arguments are presented to show that these could not have originated from scattering in the Earth's atmosphere and hence possibly have a coronal origin. (auth)

12888 EQUATORIAL CORONAL ARCHES AND GEOMAGNTEIC DISTURBANCE. Sawyer, C. (Environmental Research Labs., Boulder, CO); Hansen, S. F. Solar Phys.; 26: No. 2, 370-7(Oct 1972).

Central-meridian passage of coronal equatorial arches is followed, statistically, after about 7 days by geomagnetic disturbance. Sector-boundary crossings at Earth are most likely to occur 5 days after arch CMP, while metric noise sources cluster at the location of the arches. This agrees with the location of the noise sources relative to sector boundaries described by Sakurai and Stone (1971), rather than with that found by Martres et al., (1970) for 1964 and 1966, and may indicate evolution of the relation between coronal and interplanetary structure. Clustering of coronal arches at a particular phase of the Olsen rotation scheme was looked for. (auth)

12889 SOME STUDIES ON THE SOLAR MICROWAVE BURSTS IN RELATION TO THE SLOWLY VARYING COMPONENT. Das Gupta, M. K.; Sarkar, S. K. (Univ. of Calcutta). Solar Phys.; 26: No. 2, 378-85(Oct 1972).

The occurrences of 5772 microwave bursts recorded by the Sagamore Hill and Manilla Solar Radio Observatories over the period January 1968 to July 1970, covering the maximum phase of the current solar cycle at frequencies 2695, 4995, and 8800 MHz and their energy excesses were examined in relation to the S-component of solar radio emission. The average slowly varying component was determined by the superposed epoch method comcomly known as the Chree analysis. Similar treatment of the bursts was made to examine any probable 27-day variation and the results obtained were compared with that of the S-component. Further, spectra of the microwave bursts under the so-called spectral type — "inverted U," particularly those having a peak at 4995 MHz, were also examined and compared with the average spectrum of the S-component. Some of the important results obtained from the analysis were: (1) the nature of variation of both the average number of occurrences and energy excesses of the microwave bursts follows in general the average 27-day variation of the S-component, (2) the number of occurrences and energy excesses of the microwave bursts is comparatively greater in the ascending phase of the 27-day cycle than those in the descending phase, (3) bursts at progressively higher frequencies originate at lower levels in the solar atmosphere than those of the associated S-component, and (4) the average spectrum of the microwave bursts of "inverted U" spectral type having a peak at 4995 MHz is quite identical in nature to that of the S-component. (auth)

12890 SOLAR RADIO SPECTROGRAPH WITH HIGH TIME RESOLUTION. Gotwols, B. L.; Phipps, J. (Johns Hopkins Univ., Silver Spring, MD). Solar Phys.; 26: No. 2, 386-92 (Oct 1972).

Instrumentation for obtaining high time resolution dynamic spectra of solar radio bursts at decimetric wavelengths is described. The spectrograph sweeps the frequency range of 565 to 1000 MHz at a rate of 100 times per second. All data are recorded both on film and as an analog signal on magnetic tape. The frequency and flux calibrations are discussed. A sampling system which allows the activity at three discrete frequencies to be plotted on a chart recorder is described. (auth)

12891 ABSENCE OF FLARES IN λ3835 AND THE HEATING OF THE CHROMOSPHERE. Zirin, Harold (California Inst. of Tech., Pasadena). Solar Phys.; 26: No. 2, 393-6(Oct 1972).

Simultaneous observations of flares in Hα and a band 15 Å wide centered on 3835 Å show no change whatever in 3835 Å at the time of several flares, although the chromospheric network is easily visible. Flares are therefore transparent in this wavelength. Since the flare represents a test heat input from above, and no brightening of the network appears, it is concluded that it is impossible for the corona to produce the bright network by downward convection. (auth)

12892 X RADIATION (E > 10 keV), Hα, AND MICROWAVE EMISSION DURING THE IMPULSIVE PHASE OF SOLAR FLARES. Vorpahl, J. A. (Univ. of California, Berkeley). Solar Phys.; 26: No. 2, 397-413(Oct 1972).

A study was made of the variation in hard (E ≥ 10 keV) x radiation, Hα, and microwave emission during the impulsive phase of solar flares. Analysis showed that the rise-time in the 20 to 30-keV x-ray spike depends on the electron hardness, i.e., $t_{rise} \sim \exp(0.87\,\delta)$. The impulsive phase is also marked by an abrupt, very intense increase in Hα emission in one or more knots of the flare. Properties of these Hα kernels include: (1) a luminosity several times greater than the surrounding flare, (2) an intensity rise starting about 20 to 30 s before, peaking about 20 to 25 s after, and lasting about twice as long as the hard spike, (3) an effective diameter of 3000 to 6000 km for class ≤ 1 flares, representing less than $\frac{1}{8}$ to $\frac{1}{2}$ of the main flare, (4) a location lower in the chromosphere than the remaining flare, (5) essentially no expansion prior to the hard spike, (6) a position within 6000 km of the boundary separating polarities, usually forming on both sides of the neutral line near both feet of the same tube of force, (7) a shape often resembling isogauss contours of the photospheric field indicated on magnetograms and (8) total radiated energy less than 1/50 that of the hard electrons. Correspondingly, impulsive microwave events are characterized by: (1) the detection of a burst at 8800 MHz for every x-ray spike if the number of electrons above 100 keV is greater than 10^{33}, (2) greater similarity in burst structure with 20 to 32-keV x rays but only at f > 5000 MHz, (3) typical low-frequency burst cutoff between 1400 and 3800 MHz, and (4) maximum emission at f > 7500 MHz. Finally the Hα, x ray, and microwave data are combined to present a picture of the impulsive phase consistent with the above observations. (auth)

12893 SEARCH FOR WEAK WHITE-LIGHT FLARES BY TIME-WISE PHOTOGRAPHIC CANCELLATION. Uchida, Yutaka; Hudson, Hugh (Tokyo Univ.). Solar Phys.; 26: No. 2, 414-17 (Oct 1972).

This study proposes as a working hypothesis that small white-light flares accompany all major (proton) flare events and suggests a new method for systematically finding these "patches" of white-light emission. The new technique consists of the time-wise application of the photographic cancellation method to detect small time-varying features around the time of the impulsive phase of a flare. (auth)

12894 MAGNETIC CONFIGURATION OF THE NOVEMBER 18, 1968 LOOP PROMINENCE SYSTEM. Roy, J. R. (Sacramento Peak Observatory, Sunspot, NM). Solar Phys.; 26: No. 2, 418-30(Oct 1972).

Computed current-free magnetic fields were compared to the loop prominence associated with the west limb proton flare of November 18, 1968. Successive sets of fitting field lines closely resembled the loop prominence system throughout its growth and lifetime. The successive position bases of the field lines reproduced the drift rate of spreading two-ribbon flares. (auth)

12895 SOLAR FLARES IN THE EUV OBSERVED FROM OSO-5. Kelly, P. T.; Rense, W. A. (Univ. of Colorado, Boulder). Solar Phys.; 26: No. 2, 431-40(Oct 1972).

Solar flares in three broad euv spectral bands were observed from OSO-5 with a grating spectrophotometer. Results are given for three large flares of March 12, March 21, and April 21, 1969. In general the time dependence of flare intensity in each band was characterized by a slowly varying component with impulsive bursts superimposed. Bands 2 (465 to 630 Å) and 3 (760 to 1030 Å) were quite similar in their time variations, but band 1 (280 to 370 Å) showed less impulsive structure, and declined more slowly. Absolute euv intensities for the flares were estimated, and a comparison made with the 2800 mc s^{-1} radio emission. A flare model is proposed to account for the euv time variations during a large flare. (auth)

12896 DIRECTIVITY AND POLARIZATION OF THICK TARGET X-RAY BREMSSTRAHLUNG FROM SOLAR FLARES. Brown, J. C. (Univ. of Glasgow). Solar Phys.; 26: No. 2, 441-59(Oct 1972).

The directivity and polarization of solar hard x-ray bursts is discussed in terms of two bremsstrahlung source models. These involve continuous and impulsive injection of electrons respectively, as described widely in the literature. A detailed analysis is made of the continuous injection model in which electrons are accelerated downward into the dense chromosphere where their velocity distribution is greatly modified by collisions. This thick target scattering is described by a simple analytical model. Directivity and polarization of the bremsstrahlung emission are calculated in detail for a thick target model in which the guiding magnetic field is vertical. It is predicted for this model that x-ray sources should brighten from the center to the limb of the solar disk, while the degree of polarization should rise from zero to around 30% near the limb. The plane of maximum intensity for any source is that containing the source and the disk center. Both the directivity and polarization should increase with increasing photon energy. Very recent observations agree with these predictions though they suggest that the field is significantly nonvertical. If scattering is not included in the model, or if an impulsive injection model is taken, agreement with observations is not obtained. (auth)

12897 EVIDENCE FOR A TWO-COMPONENT INJECTION OF COSMIC RAYS FROM THE SOLAR FLARE OF MARCH 30, 1969. Palmer, I. D.; Smerd, S. F. (CSIRO, Sydney). Solar Phys.; 26: No. 2, 460-7(Oct 1972).

The solar flare of March 30, 1969 occurring ≈20° behind the west limb, produced very extensive 80 MHz radio emission at the Sun, and gave rise to the deployment of cosmic radiation over 360° long. in interplanetary space. The wide spread of this event may reflect a similar spread of coronal magnetic fields from the flare site. The solar proton data recorded by spacecraft at two separate points both at ≲1 AU are interpreted, in terms of a two-component injection of particles at the Sun consisting of: (i) a soft component which arrived promptly; (ii) a harder component which arrived later. The radio spectral and positional data provide evidence of shock waves which propagated far and wide from the flare; the precursor injection of the soft (≲10 MeV) proton component is attributed to one of these shock waves. (auth)

12898 EVIDENCE FOR ELECTRON EXCITATION OF TYPE III RADIO BURST EMISSION. Alvarez, H. (Univ. of Michigan, Ann Arbor); Haddock, F.; Lin, R. P. Solar Phys.; 26: No. 2, 468-73(Oct 1972).

Type III radio bursts observed at kilometric wavelengths (≲0.35 MHz) by the OGO-5 spacecraft were compared with >45 keV solar electron events observed near 1 AU by the IMP-5 and Explorer 35 spacecraft for the period March 1968–November 1969. Fifty-six distinct Type III bursts extending to ≲0.35 MHz (≲50 $R_\odot$ equivalent height above the photosphere) were observed above the threshold of the OGO-5 detector; all but two were associated with solar flares. Twenty-six of the bursts were followed ≲40 min later by >45 keV solar electron events observed at 1 AU. All of these 26 bursts were identified with flares located west of W09 solar longitude. Of the bursts not associated with electron events only three were identified with flares west of W09, 18 were located east of W09 and 7 occurred during times when electron events would be obscured by high background particle fluxes. Thus almost all Type III bursts from the western half of the solar disk observed by OGO-5 above a detection flux density threshold of the order of 10^{-13} Wm^{-2} Hz^{-1} at 0.35 MHz are followed by >45 keV electrons at 1 AU with a maximum flux of $\gtrsim 10$ cm^{-2} s^{-1} $ster^{-1}$. If particle propagation effects are taken into account it is possible to account for lack of electron events with the Type III bursts from flares east of the central meridian. It is concluded that streams of ≈10 to 100 keV electrons are the exciting agent for Type III bursts and that these same electrons escape into the interplanetary medium where they are observed at 1 AU. The total number of >45 keV electrons emitted in association with a strong kilometer wavelength Type III burst was estimated to be $\geq 5 \times 10^{32}$. (auth)

12899 EVIDENCE FOR THE EXISTENCE OF ADIABATIC ENERGY LOSS IN INTERPLANETARY SPACE FROM OBSERVATIONS OF THE DECAY OF THE FEBRUARY 25–MARCH 2, 1969 SERIES OF SOLAR COSMIC-RAY EVENTS. Lezniak, J. A.; Webber, W. R. (Univ. of New Hampshire, Durham). Solar Phys.; 26: No. 2, 474-83(Oct 1972).

The integral flux of low-energy protons (>10 MeV) observed by the University of New Hampshire cosmic-ray detector aboard the Pioneer 9 spaceprobe was compared with similar measurements of the near-Earth spacecraft Explorer 34 during the decay phase of the February 25–March 2, 1969 series of solar cosmic-ray events. At this time the Pioneer 9 spaceprobe was 0.8 AU from the Sun and close to the Sun–Earth radial line. The ratio of integral fluxes as measured by the separated spacecraft can be calculated theoretically during the convective phase of the decay of these events and will depend on whether energy loss processes are operative. A comparison of the observed and theoretically calculated ratios suggested that the adiabatic energy loss process is operative. (auth)

12900 NOTE ON THE ENERGIES OF SOME THREE-ELECTRON SATELLITE SPECTRUM LINES. Summers, H. P. (Cambridge Univ., Eng.). Astrophys. J.; 179: No. 1, L45-7(1 Jan 1973).

Results are given of a first-order perturbation-theory calculation of the energies of some doubly excited levels in lithium-like ions with outer electron in the n = 2, 3, and 4 principal quantum shells. These levels give rise to observed satellite spectrum lines. (auth)

12901 SOLAR NEUTRINOS AND THE INFLUENCES OF OPACITY, THERMAL INSTABILITY, ADDITIONAL NEUTRINO SOURCES, AND A CENTRAL BLACK HOLE ON SOLAR MODELS. Stothers, Richard; Ezer, Dilhan (Goddard Inst. of Space Studies, New York). Astrophys. Lett.; 13: No. 1, 45-48(Jan 1973).

Adoption of the "best" available opacities, of hypothetical additional neutrino sources, or of a central black hole in theoretical models for the Sun only increases the discrepancy with the null results of Davis's ^{37}Cl experiment to detect solar neutrinos. No thermal instabilities in any of the solar models have yet been found. (auth)

12902 PHOTOELECTRIC SPECTROPHOTOMETRY OF THE IR TRIPLET Ca II LINES AND THE CENTER AND EDGE OF THE SOLAR DISC. Melikov, G. O. Tr. Shemakh. Astrofiz. Observ., Akad. Nauk Azerb. SSR; No. 4, 6-9(Apr 1971). (In Russian).

The profiles of the ir triplet Ca II, namely, 8498.1, 8542.1, and 8662.2 Å, were investigated at two points, sine θ = 0.00 and sine θ = 0.95, where θ = the angle between the line of sight and the normal to the surface of the Sun. Spectrophotograms were obtained July 3 to 25, 1967, at the center and at the western edge of the solar disc. The results were compared with those of Hautgast (1942). (KSW)

12903 ENRICHMENT OF HEAVY NUCLEI IN THE 17 APRIL 1972 SOLAR FLARE. Fleischer, R. L.; Hart, H. R. Jr. (General Electric Research and Development Center, Schenectady, NY). Phys. Rev. Lett.; 30: No. 1, 31-4(1 Jan 1973).

Polycarbonate and glass detectors exposed on Apollo 16 to the April 17, 1972 solar flare were used to measure the spectrum of iron-group cosmic-ray nuclei down to ~0.02 MeV/N. The enrichment of iron relative to lighter nuclei previously seen at higher energies increases markedly in this new, very-low-energy region. The energy spectrum of carbon and heavier nuclei inferred from sensitized Lexan polycarbonate reveals the enrichment of iron relative to carbon and heavier nuclei down to ~0.03 MeV/N. (auth)

12904 IONIZATION BALANCE FOR IONS OF Na, Al, P, Cl, A, K, Ca, Cr, Mn, Fe, AND Ni. Landini, M.; Monsignori Fossi, B. C. (Arcetri Astrophysical Observatory, Florence). Astron. Astrophys., Suppl. Ser.; 7: No. 3, 291-310(Nov 1972).

The ionization balance is computed for ions of Na, Al, P, Cl, A, K, Ca, Cr, Mn, Fe, and Ni for temperatures from 10^4 to 10^8 K. The computations include collisional ionization, autoionization, radiative recombination, and dielectronic recombination. Computations for low-density plasmas and solar atmosphere conditions are performed. (auth)

Galaxies

Refer also to abstracts 12080 and 12816.

12905 (AD-744679) APERTURE SYNTHESIS STUDY OF NEUTRAL HYDROGEN IN THE GALAXIES NGC 6946 AND IC 342. Rogstad, D. H.; Shostak, G. S.; Rots, A. H. (Owens Valley Radio Observatory, Pasadena, Calif.). 1972. Contract N00014-67-A-0094-0019. 32p. NTIS.

Synthesis observations of neutral hydrogen emission in the two spiral galaxies NGC 6946 and IC 342 are presented. The velocity resolution is 21 km/s and the angular resolution is 2 and 4 min of arc for NGC 6946 and IC 342, respectively. Results are presented in the form of contour maps of the integral and mean velocity of the HI profile at each position in the galaxy, as well as a line profile for each galaxy as a whole. Both galaxies evidence a central depression in their HI distributions. The rotation curves have steep central gradients with rather constant velocities once the maximal velocity is reached. The HI mass for NGC 6946 is 21 billion solar mass units and for IC 342 is 15 billion solar mass units, assuming distances of 10.1 and 4.5 Mpc, respectively. Other properties are summarized in a table. (auth)

12906 STRUCTURE OF THE CEPHEID INSTABILITY STRIP IN THE SMALL MAGELLANIC CLOUD. Yakimova, N. N. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 418-25(1972).

Translated from Astron. Zh.; 49: No. 3, 514-23(1972).

Photometric parameters (color, brightness, color and brightness amplitude) in the B, V system were compared for about 30 classical Cepheids in the peripheral regions of the SMC, on the basis of Gascoigne's photoelectric data. The relations between the parameters along and across the instability strip and along lines of constant period are qualitatively the same as the relations between galactic Cepheids and the central SMC Cepheids. The behavior of the period-averaged and individual (along lines P = const) parameters indicated that the peripheral SMC Cepheids resemble peripheral galactic Cepheids more than nuclear SMC Cepheids. The mean relations between period and brightness amplitude or color at maximum light appeared to be good criteria for the membership of Cepheids in a particular group. Probably the differential absorption between the inner and outer regions of the SMC is very small; the color excess can hardly differ by more than 0.01m. (auth)

12907 TURBULENT PLASMA PILES IN THE NUCLEI OF GALAXIES. Kaplan, S. A.; Tsytovich, V. N. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 527-8(1972).

Translated from Astron. Zh.; 49: No. 3, 647-9(1972).

Turbulent plasma "piles" are regions in which power-law distributions of relativistic particles are developed. It is conjectured that such piles exist in the nuclei of galaxies, and it is shown that the maximum intensity of their radiation may be situated in the infrared range. The calculated intensity of the infrared radiation lies within the limits that correspond to the observed intensities. (auth)

12908 RESOLUTION OF ONE OF THE COMPANIONS TO M31. van den Bergh, Sidney (Univ. of Toronto). Astrophys. J.; 178: No. 3, L99(15 Dec 1972).

The dwarf spheroidal galaxy And III, which appears to be a companion to the Andromeda Galaxy, has been resolved into stars with the 200-inch (5-m) Hale telescope. (auth)

12909 FAINT SURFACE BRIGHTNESS FEATURES BETWEEN NGC 7331 AND STEPHAN'S QUINTET. Arp, Halton; Kormendy, John (Carnegie Institution of Washington, DC). Astrophys. J.; 178: No. 3, L101-3(15 Dec 1972).

Limiting exposures with the 48-inch Schmidt telescope were taken in order to search for optical connections between NGC 7331 and the region of Stephan's Quintet. Superposition printing of six such plates produced a final picture that registered stars near the 24th apparent magnitude. The superposition print revealed faint nebulous material extending southwestward from NGC 7331 toward Stephan's Quintet, and also material reaching several galaxy diameters to the west. (auth)

12910 SOFT X-RAY SURVEY OF THE GALACTIC PLANE FROM CYGNUS TO NORMA. Borken, R.; Doxsey, R.; Rappaport, S. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 178: No. 3, L115-20(15 Dec 1972).

A low-energy x-ray survey ($E \gtrsim 150$ eV) of the Cygnus region and the galactic plane from Cygnus to Norma is described. The soft x-ray emission from the Cygnus Loop was resolved into two distinct regions which contain several of the major optical filaments. Upper limits for soft x-ray emission from the supernova remnants HB 21, CTB 72, CTB 63, and W63 are given. (auth)

12911 INTERSTELLAR MAGNESIUM ABUNDANCES AND ELECTRON DENSITY IN THE DIRECTION OF ORION AND CASSIOPEIA. Boksenberg, A. (University Coll., London); Kirkham, B.; Towlson, W. A.; (and others). Nature (London) Phys. Sci.; 240: No. 102, 127-30(11 Dec 1972).

The interstellar lines of MgII and MgI in the spectra of γ Cas and γ, β, δ, and ϵ Ori were observed with a balloon-borne objective grating spectrograph. The column density of Mg relative to H was found to be close to the cosmic value for the Orion stars, but somewhat lower for γ Cas. Excluding β Ori, the average value of electron density obtained for the cool clouds in the lines of sight to these stars was $(2.8^{+1.6}_{-1.0})\ 10^{-3}$ cm^{-3}, assuming a cloud temperature of 60°K. (auth)

12912 THREE-COLOR PHOTOMETRY OF A FIELD IN THE GALACTIC ANTICENTRE SECTION NEAR NGC 1664. Becker, W.; Fang, Ch. (Univ., Basel). Astron. Astrophys.; 22: No. 2, 187-94(Jan 1973).

In a field of 0.2 square degree 1743 stars were measured in the RGU system on Palomar Schmidt plates. The limiting magnitude of the photometry was G = 18.0. The late-type giants were identified according to the conventional criteria. The additional demand that these giants should show the same interstellar reddening as main sequence stars leads to the consequence, that two types of giants exist with different intrinsic position in the color–color diagram, at both sides of the main sequence, and different distribution in space. A similar effect can be observed also in galactic star clusters. The color–color diagrams for given intervals of apparent magnitude were used for the determination of the absolute magnitude and the reddening of main sequence stars. For late-type giants of both types an absolute magnitude of M(G) = 1.0 was assumed. The interstellar reddening is caused by two clouds between 80 pc and 400 pc and between 2.2 kpc and at least 11 kpc. The density gradients for main sequence stars in different luminosity intervals generally are negative. Density gradients are also given for both types of giants separately. According to those the second type of giants with normal position at the right side of the main sequence seems to be connected with the second interstellar cloud. The combined density function for giants of both types extends to 8 kpc and coincides with the density function of main sequence stars of the same interval of absolute magnitude $0 < M(G) < +2$. No correlation was found to the spiral structure. The luminosity functions for the distance intervals from 0.5 to 1.5 kpc and from 1.5 to 2.0 kpc had lower values, but the same slope as the one for the solar neighborhood. (auth)

12913 THREE-COLOR PHOTOMETRY IN A FIELD IN THE DIRECTION OF THE GALACTIC ANTICENTRE NEAR M 35. Hersperger, Th. (Univ., Basel). Astron. Astrophys.; 22: No. 2, 195-202(Jan 1973).

2330 stars down to a limiting magnitude of G = 18.2 were measured in a field of 0.27 sq. deg. in the direction to the galactic anticenter in the RGU system. In the direction of this field, two types of late-type giants exist which have different positions with respect to the main sequence in the two-color diagram. The interstellar reddening is caused by two absorbing clouds, between 150 and 1300 pc and around 7 kpc, absorbing together 1.78 mag in G. The density functions for the main sequence stars of given intervals in absolute magnitude as well as for the late-type giants are all monotonously decreasing. The density functions for the late-type giants of both types and the one for the main sequence stars with $0 < M(G) < 2$ extend to almost 10 kpc and coincide with each other as in other anticenter fields. However, the density functions of the two types of late-type giants have different gradients, the one of the "left side" giants being generally steeper than the one of the "right side" giants. The luminosity functions of the main sequence stars were determined for distances between 1.0 and 1.4 kpc and between 1.4 and 2.4 kpc. They are considerably steeper than the luminosity function for the solar neighborhood since in this field the stars of brighter luminosity are less numerous. (auth)

12914 NEUTRAL HYDROGEN IN MARKARIAN GALAXIES. Bottinelli, L.; Gouguenheim, L.; Heidmann, J. (Observatoire, Meudon, France). Astron. Astrophys.; 22: No. 2, 281-7(Jan 1973).

The 21-cm neutral hydrogen line was measured for the first time in eleven non-Seyfert Markarian galaxies, with the Nançay radio telescope. From their optical brightness, they are compact galaxies or intermediate between compact and normal galaxies. The H I masses and indicative total masses exhibited very wide ranges of values and the relative H I content showed that they are not a homogeneous group. Ma 5 appears as an exceptional object because of its relative richness in hydrogen. The possible detection of a secondary line in Ma 201 may be connected with the ejection of a large mass of neutral hydrogen from this disrupting-like galaxy. (auth)

12915 DISTRIBUTION OF THE MASS-TO-LUMINOSITY RATIO OF SPIRAL AND IRREGULAR GALAXIES. Chiao, R. Y.; Reinhardt, M. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 22: No. 2, 257-64(Jan 1973).

The ratio of total mass to photographic luminosity M/L of spiral and irregular galaxies contained in the compilation of Roberts (1972) was analyzed statistically. Although this homogeneous and large sample suffers from selection effects with respect to luminosity and type, it nevertheless forms a representative distribution of M/L, because it is shown that M/L is independent of luminosity, mass, distance, hydrogen content, color, type, and inclination. The properties of the distribution of M/L were investigated in detail, and an analytic fit is given. One striking result of this analytic fit is that the distribution of log (M/L) is to a good approximation, gaussian. The discrepancy between the average M/L for single galaxies and that for double galaxies (Page, 1972) is discussed. Part of the discrepancy may be removed, if the individual components of the double galaxies tend to have the same M/L. The distribution for single galaxies implies a hierarchy of stages in the process of star formation, e.g., the formation of successively smaller turbulent eddies in the galactic gas until protostars are formed. (auth)

12916 STABILITY OF A SELF-GRAVITATING, NONROTATING GAS LAYER WITH STELLAR, MAGNETIC, AND COSMIC-RAY COMPONENTS. II. Kellman, S. A. (Goddard Space Flight Center, Greenbelt, MD). Astrophys. J.; 179: No. 1, 103-9(1 Jan 1973).

A time-independent linear stability analysis was performed on a self-gravitating, plane-parallel, isothermal layer of nonrotating gas with magnetic and cosmic-ray components. The gas layer is immersed in a rigid plane-stratified isothermal layer of stars which supply a self-consistent gravitational field. The stability analysis was confined to disturbances which propagate along the magnetic field. The principal result to emerge from this study was that the magnetic field and cosmic-ray gas hinder gravitational instability, increasing the minimum length necessary to produce instability approximately by the factor $(1 + \alpha + \beta)^{1/4}$, where α is the ratio of magnetic pressure to gas pressure and β is the ratio of cosmic-ray pressure to gas pressure. The author has recently shown that a similar result applies when disturbances propagate across the magnetic field. (auth)

12917 PROPERTIES OF THE REDSHIFT–MAGNITUDE BANDS IN THE COMA CLUSTER. Tifft, W. G. (Univ. of Arizona, Tucson). Astrophys. J.; 179: No. 1, 29-44(1 Jan 1973).

Redshifts of additional faint galaxies in the Coma cluster are given. A total of 108 galaxies with redshift and magnitude data is now available and is discussed with regard to both nuclear-region and total magnitude. The banded correlation previously discussed by Tifft is shown to be convergent toward zero redshift and possibly to possess a discrete structure along each band which correlates with galaxy angular momentum. The statistical significance of the banded correlation is investigated by power-spectrum analysis, and implications of the correlations are briefly discussed. (auth)

12918 STABILITY OF CLUSTERS OF GALAXIES WITH MASS LOSS TO GRAVITATIONAL RADIATION. Dearborn, D. S. (Univ. of Texas, Austin). Astrophys. J.; 179: No. 1, 45-53(1 Jan 1973).

The effects of various rates of assumed mass loss to gravitational radiation on a cluster of galaxies are studied using a N-body problem solver. It is shown that such mass loss will cause an initially stable cluster to become unstable. The then unstable cluster exhibits a mass discrepancy on the order of those observed in actual clusters. The distributions of the theoretical clusters are then compared to the observed distributions of the spiral and elliptical clouds in the Virgo cluster. (auth)

12919 VELOCITY DISPERSIONS IN GALAXIES. II. THE ELLIPTICALS NGC 1889, 3115, 4473, AND 4494. Morton, D. C.; Chevalier, R. A. (Princeton Univ. Observatory, NJ). Astrophys. J.; 179: No. 1, 55-68(1 Jan 1973).

Coudé spectra with 0.9 Å resolution between 4185 and 4415 Å were obtained from the galaxies NGC 1889 (E0), 3115 (E7/S0), 4473 (E5), and 4494 (E1) with an integrating television sensor. Comparison with spectra of G5 III, G8 III, and K0 III stars broadened by various Gaussian velocity profiles showed that these galaxies have velocity dispersions in their nuclei of $\sigma = 110 \pm 20$, 215 ± 20, 160 ± 30, and 160 ± 20, respectively. These results, together with those obtained by Minkowski and others indicate a continuous distribution of dispersions from 60 km s^{-1} for M32 to 490 km s^{-1} for M87. The wavelength shifts required to superpose the galaxies on the broadened star spectra also gave new determinations of the galaxy radial velocities. Rotation curves were derived for the inner parts of NGC 3115 and 4473. A simple application of the virial theorem gave masses of 5×10^{10}, 1.6×10^{11}, 1.5×10^{11}, and 1.2×10^{11} $M_\odot$ and ratios of mass to photographic light of 22, 38, 6, and 9, respectively, for a Hubble constant of 100 km s^{-1} Mpc^{-1}. (auth)

12920 STAR FORMATION AND EVOLUTION IN SPIRAL GALAXIES. Quirk, W. J. (Carnegie Institution of Washington, DC); Tinsley, B. M. Astrophys. J.; 179: No. 1, 69-83(1 Jan 1973).

Evolutionary models for regions of M31 and M33 and the solar neighborhood are based on a stellar birthrate suggested by the dynamics of spiral structure: it is assumed that stars are formed very efficiently until the gas content reaches equilibrium at its present value, which takes about 10^9 years; thereafter, the birthrate just equals the rate at which gas enters the system from stellar mass-loss or infall of intergalactic matter. Each model represents an average around a cylindrical-shell-shaped region, which is homogeneous and closed except for possible infall. The disk and spiral-arm populations only are considered. Each star is followed in the H–R diagram from the main sequence to death as an invisible remnant. Integrated magnitudes, colors, mass-to-light ratio (M/L), gas content, helium and metal abundance (Z), are computed in steps of 10^9 years. For regions of M31 and M33 only the Salpeter initial mass function (IMF) is used. With this restriction, successful models can be obtained provided the infall rate and lower mass limit are suitably chosen. The gradient of lower limit required to give the observed gradient of M/L results in a decrease outwards of Z, in qualitative agreement with observation. The solar-neighborhood IMF is adjusted to give rise to the observed present-day luminosity function at age 11×10^9 years. The rapid initial birthrate results in such depletion of deuterium that, if there is no infalling intergalactic gas, the solar abundance cannot be explained; also, the solar Z is far too great unless at least half of the local hydrogen is hidden in molecular form. But if infall occurs at 2% of the local mass per 10^9 years, one can obtain a model which solves these problems and is consistent with the local M/L, distribution of Z among G dwarfs, abundances of long-lived r-process elements, supernova rate, and birthrate of white dwarfs. (auth)

12921 Hα FLUORESCENCE IN THE FILAMENTS OF M82. Van Blerkom, David (Univ. of Massachusetts, Amherst); Castor, J. I.; Auer, L. H. Astrophys. J.; 179: No. 1, 85-8(1 Jan 1973).

Polarization of Hα radiation from the filaments of M82 has previously been attributed to scattering off dust of light emitted by a central source. It is difficult, however, to find a physically plausible velocity distribution of the scattering material to account for the observed line displacements in the filaments. The simplest interpretation, that of matter ejected by a single explosive event, requires the Hα emission to be intrinsic to the filaments. It is proposed that Hα is produced in the filaments by fluorescence. This eliminates the velocity distribution problem posed by scattering and gives 29% as the degree of polarization, which is very nearly the observed value. The physical requirements of this process appear plausible for M82. A possible test of the hypothesis lies in the predicted Balmer decrement $I(H\alpha)/I(H\beta) \geq 20$. This is much higher than would be expected if radiative recombination, collisional excitation, or extinction by dust in a Seyfert-like nucleus controlled the Balmer-line intensities. (auth)

12922 SPECTRA OF MARKARIAN GALAXIES. I. Arakelyan, M. A.; Dibai, E. A.; Esipov, V. F. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 6: No. 1, 14-21(1970).

Translated from Astrofizika; 6: No. 1, 39-47(1970).

A spectroscopic study of 33 galaxies with strong ultraviolet continuum was carried out using a spectrograph with an electron-optical converter working in conjunction with the 125-cm reflector at the Crimean Station of the Shternberg State Astronomical Institute. Emission lines were found in the spectra of 22 of these objects. The redshifts, absolute photographic magnitudes, and equivalent widths of emission lines were found for 20 objects. Objects Nos. 79, 106, 124, 141, 205, and probably Nos. 99 and 105 have broad hydrogen and narrow nebular lines characteristic for the nuclei of Seyfert galaxies. (auth)

12923 ANDROMEDA GALAXY M 31. II. HYDRODYNAMIC MODEL, THEORY. Einasto, Ya. E. Astrophysics (Engl. Transl.); 6: No. 1, 69-75(1970).

Translated from Astrofizika; 6: No. 1, 149-63(1970).

The problem of constructing a hydrodynamic model of a stellar system from a given mass distribution is discussed. The set of equations for the determination of the kinematic functions is given, i.e., the velocity dispersion, the centroid velocity, the dispersion ratios, and the inclination of the major axis of the velocity ellipsoid to the plane of symmetry of the galaxy. There are only two hydrodynamic equations for these five functions. Three further equations are therefore necessary to solve the problem. Various methods of closing this set of hydrodynamic equations are described and analyzed. It is, in fact, a set of nonlinear differential equations which can be solved by the method of successive approximations. The solution of the equations in the plane of the galaxy ($z = 0$) is discussed in detail and, in general ($z \neq 0$). (auth)

12924 RADIO CONTINUUM OF THE LARGE MAGELLANIC CLOUD. I. THE SOURCES AT 6 CM WAVELENGTH. McGee, R. X.; Brooks, J. W.; Batchelor, R. A. (CSIRO, Epping, Australia). Aust. J. Phys.; 25: No. 5, 581-97(Oct 1972).

The Large Magellanic Cloud was surveyed in the radio continuum at a wavelength of 6 cm with the 4′ arc beam of the Parkes radio telescope. A catalogue of 95 sources and diagrams of their brightness contours are presented. (auth)

12925 RADIO CONTINUUM OF THE LARGE MAGELLANIC CLOUD. II. CONTINUUM OBSERVATIONS AT 11 CM WAVELENGTH. Broten, N. W. (National Research Council of Canada, Ottawa). Aust. J. Phys.; 25: No. 5, 599-612(Oct 1972).

Contour diagrams are presented for the radio continuum brightness of the Large and Small Magellanic Clouds observed at a wavelength of 11 cm. The observations were made with the Parkes 64 m radio telescope, whose half-power beamwidth was 7 · 35′ arc. (auth)

12926 RADIO CONTINUUM OF THE LARGE MAGELLANIC CLOUD. IV. SPECTRA OF SOURCES. McGee, R. X.; Newton, L. M. (CSIRO, Epping, Australia). Aust. J. Phys.; 25: No. 5, 619-35(Oct 1972).

The continuum radio sources in the direction of the Large Magellanic Cloud are classified in terms of their spectral indices. Of 52 sources for which spectral data were available three distinct classes exist: (1) sources with spectral indices ≥ -0.20, of which 21 out of 23 have been identified with HII regions in the Henize catalogue; (2) sources with spectral indices < -0.20 that have been identified with Henize objects, of which it is possible that many are supernova remnants; and (3) sources with spectral indices < -0.20 that have not been identified with optical objects and are considered to be outside the LMC. Six "double sources" with one member belonging to class (1) and the other to class (2) were found. The background continuum radiation is also discussed. (auth)

12927 RADIO CONTINUUM OF THE LARGE MAGELLANIC CLOUD. III. THE SOURCES AT 11 CM WAVELENGTH. McGee,

R. X.; Brooks, J. W.; Batchelor, R. A. (CSIRO, Epping, Australia). Aust. J. Phys.; 25: No. 5, 613-17(Oct 1972).

A catalogue is given of radio sources observed in the Large Magellanic Cloud at 11 cm wavelength. A map of the radio brightness in the 30 Doradus region is included. The observations were made with a low-noise correlation radiometer and the Parkes 64 m radio telescope. (auth)

12928 SHOCK WAVES IN SPIRAL ARMS AND STAR FORMATION. Pikel'ner, S. B. (Sternberg Astronomical Inst., Moscow). Comments Astrophys. Space Phys.; 4: No. 5, 129-36 (1972).

Properties of shock waves in spiral arms are reviewed and the effects of these shock waves on star formation are considered. (WDM)

12929 INTERSTELLAR MOLECULAR HYDROGEN OBSERVED IN THE ULTRAVIOLET SPECTRUM OF DELTA SCORPII. Smith, A. M. (Goddard Space Flight Center, Greenbelt, MD). Astrophys. J.; 179: No. 1, L11-15(1 Jan 1973).

Molecular-hydrogen bands of the Lyman and Werner systems have been observed in the ultraviolet, interstellar spectrum of δ Sco. The average molecular column density is $3.5\ (+2.2, -0.9) \times 10^{19}$ cm^{-2}, and the average temperature of the gas of which the molecules are part is 47°K. Minimum and maximum gas temperatures are 25 and 98°K, respectively. The observed column density of hydrogen atoms is $(1.5 \pm 0.5) \times 10^{21}$ cm^{-2}, and hence the ratio of the number of hydrogen atoms in molecular form to the total number of hydrogen atoms in either atomic or molecular form is 0.044 (+0.070, −0.018). (auth)

12930 DIFFERING MOLECULAR LINE WIDTHS IN DENSE INTERSTELLAR CLOUDS. Heiles, Carl (Univ. of California, Berkeley). Astrophys. J.; 179: No. 1, L17-19(1 Jan 1973).

In Sgr B2 and Orion A, radio astronomers observe different line widths for different molecules, or for different transitions within the same molecule. This behavior is consistent with the increasing density and decreasing collapse velocity toward the center found in theoretical models of isothermal collapsing protostars. (auth)

12931 PHYSICS OF THE X-RADIATION FROM CLUSTERS OF GALAXIES. Sofia, Sabatino (Univ. of South Florida, Tampa). Astrophys. J.; 179: No. 1, L25-9(1 Jan 1973).

By examining the data relating to the Perseus, Virgo, and Coma clusters of galaxies, it is shown that the x-ray luminosity at 2 to 10 keV is directly proportional to the average virial mass per galaxy in the cluster. If it is assumed that the missing mass exists and that it is in the form of gas, then this proportionality suggests that the heating of the x-ray-emitting cloud is due to bombardment by cosmic rays produced in the active galaxy found in each of the cluster sources. The x radiation, then, is optically thin bremsstrahlung radiation produced by the (not necessarily isothermal) hot gas. The consequences of this model are examined, and it is shown that it leads to values for the cluster parameters in good agreement with the observations. (auth)

12932 APERTURE SYNTHESIS OBSERVATIONS OF MAFFEI 2 AT λ 21 cm. Wright, M. C. H. (National Radio Astronomy Observatory, Green Bank, WV); Seielstad, G. A. Astrophys. Lett.; No. 1, 1-7(Jan 1973).

Maffei 2 is established as rotating early-type spiral galaxy with a total mass exceeding 2.5×10^9 D[Mpc] $M_\odot$ and a fractional hydrogen content less than 0.015 D, where D is the distance to the galaxy. The continuum emission has nuclear, disk, and halo components. (auth)

12933 PHOTOELECTRIC SPECTROPHOTOMETRY OF MARKARIAN 205 AND A NEARBY SUSPECTED RADIO SOURCE. Oke, J. B. (California Inst. of Tech., Pasadena); Tovmassian, H. M. Astrophys. Lett.; 13: No. 1, 9-11(Jan 1973).

A star-like object at the position of a radio source near Markarian 205 is found to be a late-type star. Markarian 205 is a very luminous Seyfert galaxy which has a spectrum almost identical with that of the Markarian galaxy 79. (auth)

Cosmology

12934 PTOLEMY–COPERNICUS PROBLEM. Polishchuk, R. F. Sov. Astron. AJ (Engl. Transl.); 16: No. 3, 549-51(1972). Translated from Astron. Zh.; 49: No. 3, 669-71(1972).

A mathematical interpretation is given of the general-relativity distinction between the Ptolemaic and Copernican systems, using the concept of a "canonical standard frame," with a consistent discrimination between a "standard frame" (invariance) and a "coordinate system" (arbitrariness). (auth)

12935 PERTURBATIONS ON THE MIXMASTER UNIVERSE. Hu, B. L. (Princeton Univ., NJ); Regge, T. Phys. Rev. Lett.; 29: No. 24, 1616-20(11 Dec 1972).

Mathematical formalisms for the separation and solution of the tensor perturbation equations in an empty, diagonal, type-IX space is developed, based upon group-symmetry properties of homogeneous spaces. Numerical results in sampling solutions of the "mixmaster universe" show damping amplitudes of perturbations as the universe expands, a behavior in qualitative accordance with earlier results on the Friedmann universe. (auth)

12936 GRAVITATING SPHERICAL SHELL. Frehland, E. (Univ., Freiburg i. B.). Ann. Phys. (Leipzig); 28: No. 1, 91-3(1972).

Treder (1970) gave the definition of a surface density of matter in general relativity by essential discontinuities of the first derivatives of the metric $g_{\mu\nu}$. These results are applied to concrete problems, e.g., by connecting known vacuum solutions with material sources of surface-density structure. The practicability of this procedure is demonstrated by the simple example of a gravitating spherical shell. (W.D.M.)

12937 VACUUM DISPERSION, PHOTON REST MASS, AND THE SPEED OF LIGHT IN A GRAVITATIONAL FIELD. Woodward, J. F.; Yourgrau, W. (Univ. of Denver). Ann. Phys. (Leipzig); 28: No. 1, 88-90(1972).

Recently Breinhorst and Reinhardt (1971) commented on a paper by the authors (1970). A reply to their comments is given. (W.D.M.)

12938 ULTRAVIOLET BACKGROUND RADIATION. Henry, R. C. (Naval Research Lab., Washington, DC). Astrophys. J.; 179: No. 1, 97-102(1 Jan 1973).

The high-galactic-latitude ultraviolet background flux was measured and was 1900(+0, −950) photons (cm^2 s sterad Å)$^{-1}$, at 1450 Å, as seen with a 10° field-of-view detector. This was in good agreement with a value obtained by Lillie with the Wisconsin experiment on OAO-2, which had a much smaller field of view. (auth)

12939 POSSIBLE VERIFICATION OF ARP'S HYPOTHESIS. Babadzhanyants, M. K. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 6: No. 1, 78-9(1970).

Translated from Astrofizika; 6: No. 1, 170-3(1970).

Arp's hypothesis on the ejection of certain radio sources (quasars, N galaxies, etc) from a parent galaxy combines in a single physical group objects with essentially different redshifts. The redshifts are shown as functions of apparent magnitude and corrected apparent magnitude and it is seen that there is a statistically random relation between members of the associations identified by Arp. (WDM)

12940 QUASARS AS PROTOCLUSTERS OF GALAXIES. Vorontsov-Vel'yamihov, B. A. (State Astronomical Inst., Moscow). Astrophysics (Engl. Transl.); 6: No. 1, 47-9(1970).

Translated from Astrofizika; 6: No. 1, 101-7(1970).

A hypothesis is put forward according to which dense bodies (QSG), which occasionally transform into quasars, decay into components and their subsequent fragmentation results in the formation of groups and clusters of galaxies. Recurrent nonthermal radio emission continues during all the subsequent stages of fragmentation and evolution of the QSG's, and the fraction of nonthermal optical emission decreases. This hypothesis explains the absence of quasars from clusters of galaxies, their complex radio structure, the structural details of clusters, and the distribution of radio galaxies in them. The gravitational redshift component becomes appreciable and the requirements imposed on the energy output per unit mass of the quasars become less demanding. This hypothesis puts into concrete terms Ambartsumyan's idea about the cascade fragmentation of dense material and the dispersion of fragments in the form of disintegrating stellar systems. (auth)

12941 MAXWELL EQUATIONS IN A SPHERICALLY SYMMETRIC BLACK-HOLE BACKGROUND AND RADIATION BY A RADIALLY MOVING CHARGE. Tiomno, J. (Inst. for Advanced Study, Princeton, NJ). Lett. Nuovo Cim.; 5: No. 13, 851-5 (25 Nov 1972).

The problem of the radiation emitted by a point charge of, with mass m_0, moving radially in a Reissner–Nordström black-hole background is considered. The problem of separation of Maxwell equations in spherical coordinates is re-examined by expressing the field quantities and the stress tensor in terms of a new field quantity. Thus equations more appropriate for numerical integration is problems when the particle is not always at a finite r are obtained and applied to the radial motion problem. The amount of em radiation emitted both outwards and into a Schwarzschild

black hole by a particle falling radially starting at rest from infinity is obtained. (WDM)

12942 METAGALACTIC OPACITY TO PHOTONS OF ENERGY LARGER THAN 10^{17} eV. Bonometto, S. A.; Marcolungo, P. (Univ., Padua). Lett. Nuovo Cim.; 5: No. 8, 595-603(21 Oct 1972).

It is shown that the most important effect limiting the transparency of the universe to photons (and electrons) of energy larger that 10^{17} eV is likely to be the third-order process, $\gamma + e^{\pm} \rightarrow e^{\pm} + e^{+} + e^{-}$, called induced pair production. (WDM)

12943 SCALAR WAVES AND TENSOR PERTURBATIONS IN THE MIXMASTER UNIVERSE. Hu, B. L. Princeton, NJ; Princeton Univ. (1972). 167p. University Microfilms Order No. 72-29,791.

Thesis.

Studies on scalar waves in the Mixmaster Universe are directed towards an understanding of the interaction between matter and geometry—how anisotropic vibration of the Universe effects particle creation and how particle creation changes the geometry of the Universe. (TSS) (Diss. Abstr. Int., B)

12944 PROBLEMY SOVREMENNOI KOSMOGONII. (Problems in Contemporary Cosmogony). Ambartsumyan, V. A. (ed.). Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1972). 472p.

This monograph on contemporary cosmogony consists of five chapters, each written by a different author with a separate bibliography. The significance of nonstationary objects in the cosmos to research on the origins and evolutions of the heavenly bodies is evaluated. Two chapters focus attention on the cosmogony of stars and galaxies, and the solar system, respectively. The theory of super-dense bodies is explored: possible phase states of matter, pulsars, and theory of gravitation and superdense configurations. A paper on the contemporary state of cosmogonic theory examines the crisis in classical cosmogony, trends in stellar cosmogony, and trends in the cosmogony of the solar system. (KSW)

12945 GRAVITATIONAL ENERGY AND CONSERVED CURRENTS IN GENERAL RELATIVITY. Keefer, B. G. Vancouver, B. C.; Univ. of British Columbia (1972). National Library of Canada, Ottawa.

Thesis.

The problem of the definition of gravitational energy is reconsidered. Following a review of earlier works, a study is made of physical and geometric considerations which might select usefully distinguished gravitational complexes and reference frames. This investigation is conducted within the vierbein formulation of general relativity. Conserved currents corresponding to generalized energy, momentum, and spin are derived from action principles. These currents transform as vector densities under general coordinate transformations, but depend on the vierbein frame chosen. The expressions for the energy and momentum currents are not unique, as their general expression contains three arbitrary constants. Physical examples are used to test possible choices of these constants and possible vierbein frames. The generalized vierbein energy and momentum currents are calculated for asymptotically flat, radiative space–times. The physical requirements that the energy of an isolated system cannot increase when there is no incoming radiation, and that there be invariance under vierbein transformations respecting boundary conditions appropriate to the asymptotic symmetry group, are imposed on the generalized energy integral. These requirements determine a unique expression for the energy current which contains no second order field derivatives. Since the boundary conditions do not specify the vierbein frame everywhere, the distribution of gravitational energy is not well defined even when the concept of total energy is made legitimate by asymptotic space–time symmetry. It has been conjectured repeatedly that a local density of gravitational energy could be defined even in the absence of space–time symmetries through a suitable choice of gravitational complex and of reference frame. This is certainly attainable in a formal sense, as invariant vierbein frames are defined by the principal directions of the curvature tensor and of the energy–momentum tensor of matter It is shown by the consideration of gravitational radiation fields that such definitions will not suffice to localize gravitational energy. (Diss. Abstr. Int., B)

Planetary Phenomena

Refer also to abstract 12724.

12946 (N-72-22812) RADIOACTIVITY IN RETURNED LUNAR MATERIALS. Semiannual Progress Report, August 1, 1971–January 31, 1972. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Feb 1972. 26p. (NASA-CR-115503; SAPR-2). NTIS.

The ^{3}H, ^{37}Ar, and ^{39}Ar radioactivities were measured at several depths in the large documented lunar rocks 14321 and 15555. The comparison of the ^{37}Ar activities from similar locations in rocks 12002, 14321, and 15555 gives direct measures of the amount of ^{37}Ar produced by the November 2, 1969, and January 24, 1971, solar flares. The tritium contents in the documented rocks decreased with increasing depths. The solar-flare intensity averaged over 30 years obtained from the tritium depth dependence was approximately the same as the flare intensity averaged over 1000 years obtained from the ^{37}Ar measurements. Radioactivities in two Apollo 15 soil samples. ^{3}H in several Surveyor 3 samples, and tritium and radon weepage were also measured. (auth)

12947 ABUNDANCE OF CH_3D AND THE D/H RATIO IN JUPITER. Beer, Reinhard; Taylor, F. W. (Jet Propulsion Lab., Pasadena, CA). Astrophys. J.; 179: No. 1, 309-27(1 Jan 1973).

From observations of the ν_2 parallel band of mono-deuterated methane (CH_3D) in the Jovian atmosphere, a CH_3D abundance and mixing ratio and a value for the D/H ratio in this planet were derived, with due regard to the problems of Jovian atmospheric structure and deuterium fractionation. It was found the D/H ratio is significantly less than the terrestrial value and some of the implications to the early history of the solar system are discussed. This observation marks the firstever detection of deuterium by any astronomical technique. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstract 13676.

12948 (N-72-23373) DEVELOPMENT OF A WORLDWIDE MODEL FOR F LAYER-PRODUCED SCINTILLATION. Final Report. Fremouw, E. J.; Rino, C. L. (Stanford Research Inst., Menlo Park, Calif.). Nov 1971. Contract NAS5-21551. 128p. (NASA-CR-122392). NTIS.

An empirical approach to modeling the electron-density irregularities in the F layer of the Earth's ionosphere that are primarily responsible for scintillation of transatmospheric vhf-uhf signals has been devised and tested. The work was directed toward two major goals: first, development of a worldwide model for describing the rms fluctuation in signal strength to be expected on an arbitrary satellite-to-Earth communication link under average ionospheric conditions; and, second, investigation of the feasibility of similar modeling for description of the complete first-order distribution of signal strength. (auth)

12949 EFFECT OF THE VERTICAL DRIFT IN THE EQUATORIAL F REGION. Wu, M. F. (Massachusetts Inst. of Tech., Cambridge). Radio Sci.; 7: No. 12, 1079-84(Dec 1972).

Numerical solutions of the continuity equation for electrons are obtained for the purpose of testing the vertical-drift effect on the plasma distributions in the equatorial F region of the Earth's ionosphere. The results have shown that the altitude profile of electron density and the accompanied vertical-drift velocity measured at Jicamarca are consistent and confirmed that electromagnetic lifting is the major factor to cause the equatorial anomaly as suggested by Martyn [1955]. The calculated values are found to be in good agreement with the observations both in magnitudes and in distributica patterns. (auth)

12950 SOME ASPECTS OF THE DAY-TO-DAY VARIABILITY OF THE EQUATORIAL ANOMALY: AMERICAN AND JAPANESE SECTORS. Rush, C. M. (Air Force Cambridge Research Labs., Bedford, MA); Miller, D. Radio Sci.; 7: No. 12, 1085-94(Dec 1972).

The day-to-day variability observed in the structure of the equatorial anomaly during a period of high solar activity is investigated. Using hourly values of f_0F2 observed at a number of ionosonde locations in the American and Japanese longitude sectors during 1958, the structure of the equatorial F2 region has been obtained on an hourly basis for an entire year. It is observed that the equatorial anomaly shows considerable day-to-day fluctuations in both its structure and its diurnal development. The anomaly is generally best developed in the evening hours, and day-to-day changes in the time of best development are typically on the order of 2 to 4 hr. It is observed that the time when the anomaly attains its maximum development is not the same on both sides of the magnetic equator, although this time is closer to coincidence during the equinoctial months than during the solstices. Also during the equinoctial months, the anomaly crests tend to be more symmetric about the equator than during the solstices. The relative magnitudes of the crests display a noticeable changeover with time during the northern solstice in both longitude sectors. The crest on the winter side of the magnetic equator is larger during the day, and the summer crest is larger at night. The exact time that this changeover occurs varies on the order of 5 to 7 hr on a day-to-day basis. During the southern solstice this crest changeover is observed only in the Japanese sector. (auth)

12951 ESTIMATION OF THE CUMULATIVE AMPLITUDE PROBABILITY DISTRIBUTION FUNCTION OF IONOSPHERIC SCINTILLATIONS. Whitney, H. E.; Aarons, J.; Allen, R. S.; Seemann, D. R. (Air Force Cambridge Research Labs., Bedford, MA). Radio Sci.; 7: No. 12, 1095-1104(Dec 1972).

The fading characteristics of ionospheric amplitude scintillations can be described by a cumulative amplitude probability distribution function (cdf). The cdf expresses the probability (percentage of time) that the signal amplitude will equal or exceed a given amplitude. Distributions of amplitude variations are made with the use of ionospheric scintillations observed on beacon signals from synchronous satellites transmitting at 136 MHz. The resulting distributions are divided into six groups corresponding to ranges of the scintillation index, the predominant measure in scintillation studies. The model distributions are then combined with the occurrence of scintillations in various index ranges to produce cumulative amplitude probability distributions. These have been done for long-term observations made at Hamilton, Massachusetts, Narssarssuaq, Greenland, and Huancayo, Peru. The results allow engineers to determine margins necessary for communication and navigation systems. Individual 15-min distributions have been compared to the theoretical distributions obtained by Nakagami [1960] in his m-distribution method of characterizing amplitude scintillation and were found to be in good agreement. The m parameter is shown to be a measure of the frequency dependence of scintillations and can be used to determine a spectral index for interpolating the amplitude distributions to other frequencies of interest. (auth)

12952 REFLECTION OF FM ELECTROMAGNETIC PULSES FROM THE IONOSPHERE. Sodha, M. S.; Rattan, I.; Chakravarti, A. K. (Indian Inst. of Tech., New Delhi). Radio Sci.; 7: No. 12, 1113-15(Dec 1972).

Tractable analytical results were derived for the distortion of the amplitude, the pulse length, and the rate of frequency shift of an FM Gaussian pulse after it has undergone reflection from an ionospheric model with a linear electron-density profile and constant collision frequency. (auth)

12953 D LAYER ABSORPTION AND GEOMAGNETIC ACTIVITY. Bossolasco, Mario; Elena, Antonio (Univ., Genoa). Compt. Rend., Ser. B; 275: No. 13, 469-72(25 Sep 1972). (In French).

The nondeviate absorption of the D layer of the ionosphere at midday following an intense geomagnetic storm in the middle latitudes reaches a maximum about 1½ days after the abrupt beginning of the storm, i.e., 3 days after the solar flare responsible for the storm. (France)

12954 ONSET OF STRIATIONS IN BARIUM CLOUDS. Shiau, J.-N.; Simon, A. (Univ. of Rochester, NY). Phys. Rev. Lett.; 29: No. 25, 1664-7(18 Dec 1972).

A numerical technique is used to solve equations that describe growth of a barium cloud in the ionosphere, including arbitrary end-shorting ratio λ. For λ corresponding to actual releases, one finds growth of a limited range of wavelengths k grouped around a maximum growing k. The growth rate and k range are sensitive functions of electric field E and λ. Stability occurs below a critical E and for strong shorting. The growing modes are localized on the rear of the cloud. All modes are unstable for no shorting. (auth)

12955 EFFECTS OF RADIO-WAVE PROPAGATION IN THREE-DIMENSIONAL NONUNIFORM MAGNETOACTIVE IONOSPHERE. Krokhmal'nikov, E. B.; Solodovnikov, G. K. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 9, 1304-13(1972). (In Russian).

In the geometrical optics approximation a number of effects taking place when propagating in a three-dimensional nonuniform magnetoactive nonstationary ionosphere are investigated. For the USW case, the ionospheric effects are described by approximative formulas obtained when the differential ray equations are solved, taking into account the magnetic field. Quantitative estimations of the Earth magnetic-field influence on radio-wave propagation in the ionosphere are presented. (tr-auth)

12956 ROCKET-BORNE INSTRUMENTATION TO MEASURE IONOSPHERIC ELECTRON TEMPERATURE WITH GOOD SPATIAL RESOLUTION. Wrenn, G. L. (University Coll., London)· Blades, J. Rev. Sci. Instrum.; 43: No. 11, 1581-7(Nov 1972).

An ac Langmuir probe technique has been developed in order to make measurements of electron temperature in the lower ionosphere with good temporal and spatial resolution. The requirement to counter changes in rocket potential led to the incorporation of a servo system on the collector bias voltage and a novel method of sweeping this bias to analyze the electron retardation current characteristic. Sweep rates of 45 Np/sec have proved feasible and almost continuous monitoring of electron temperature appears possible. The provision of a real plasma reference should also be valuable for other ionospheric instruments, e.g., ion mass spectrometers, low energy particle detectors, and electric field sensors. (auth)

Magnetospheric Phenomena

Refer also to abstract 12079.

12957 (AD-743888) OBSERVATION OF VLF WHISTLER-MODE WAVES PECULIAR TO THE RADIATION BELT SLOT.

Report for April 1968–July 1971. Koons, H. C.; McPherson, D. A. (Aerospace Corp., El Segundo, Calif.). 22 May 1972. Contract F04701-71-C-0172. 22p. (SAMSO-TR-72-110). NTIS.

Vlf emissions between 3.9 and 10.4 kHz are observed at high altitudes in the slot region (L approximately 2.5 to 3.6) by a receiver aboard spacecraft OV1-14 (1968-26B). The maximum spectral intensities of 1.1 microgamma/(Hz to the $\frac{1}{2}$ power) and 2.8 microvolt/(Hz to the $\frac{1}{2}$ power) on the magnetic and electric antennas, respectively, occur in the 5.6-kHz channel. The waves can resonantly interact with energetic electrons above approximately 50 keV at L = 2.5, and the measured wave intensities are ample to account for the observed lifetimes of medium-energy electrons in the slot region. (auth)

12958 (N-72-22381) MAGNETOSPHERIC PLASMA PHENOMENA AT THE GEOSTATIONARY ORBIT. Freeman, J. W. Jr.; Young, D. T. (Rice Univ., Houston, Tex. Dept. of Space Science). Mar 1971. 10p. (NASA-CR-126237). NTIS.

The principal phenomena detected by the low-energy plasma detector onboard the ATS-1 geostationary satellite are reviewed. They can be classed as: (1) directed flow of cool magnetospheric plasma; (2) magnetopause plasma flow; (3) plasma sheet dynamics; (4) hydromagnetic wave-induced plasma motion. The magnetosphere near the geostationary orbit is rich in phenomena accessible to a low-energy plasma detector on a spinning spacecraft. (auth)

12959 CHARACTERISTICS OF THE PULSE SPECTRA OF PI 2 TYPE ALONG A MERIDIAN PROFILE. Raspopov, Oleg (Leningrad State Univ.); Kochelevskii, Vladimir; Roquet, Juliette; (and others). Compt. Rend., Ser. B; 275: No. 13, 465-8(25 Sep 1972). (In French).

Pi-2 pulsations recorded along a meridian exhibit a secondary amplitude maximum in a 50 to 60° geomagnetic latitude and possess a relative increase in high frequencies at small latitudes. (France)

12960 ELECTRON ECHO EXPERIMENTS: COMPARISON BETWEEN OBSERVED AND PREDICTED TRAJECTORIES OF ELECTRONS ARTIFICIALLY INJECTED INTO THE MAGNETOSPHERE. McEntire, R. W. Minneapolis; Univ. of Minnesota (1972). 266p. University Microfilms Order No. 72-32,310.

Thesis.

On August 13, 1970, a sounding rocket launched from Wallops Island, Virginia, was used to successfully inject a controlled beam of energetic electrons into the trapping region of the Earth's magnetosphere. The Aerobee-350 rocket carried a high-voltage electron gun, electron detectors, receivers to measure the electric field of waves generated by the experiment, and other apparatus to a peak altitude of 350 km. More than 3000 16-msec long, 70-mA pulses of 35- to 43-keV electrons were injected into the magnetosphere during the 10-minute flight, with pitch angles within 25° of the local 90° mirror angle. The electrons, trapped in the geomagnetic field, bounced between the mirror point near the rocket and the southern conjugate point (−66° latitude, −82° longitude) while drifting eastward across field lines on a drift shell of constant McIlwain L parameter (2.58) under the gradient and curvature forces. Since Wallops Island conjugate mirror altitudes are at least 300 km lower than injection altitudes, all returning electrons were backscattered from the atmosphere in the southern hemisphere. The rocket was launched eastward in an attempt to intercept the returning electrons and, for a 90-second interval about L-apogee, electrons were detected returning from one, two, and in one case, three complete bounces to the southern hemisphere and back. The analyzed electron data agree well with echo patterns predicted from theoretical particle motion in models of the geomagnetic field combined with Monte Carlo studies of energy loss and diffusion in the conjugate point atmosphere. However, the returning flux was lower than predicted and discrepancies between theory and experiment were observed at large diffusion distances. This experiment, Electron Echo I, verified the concept of using controlled particle beams as magnetospheric probes, showing that such beams are stable and can be intercepted after bounces to the conjugate point and back. Future Electron Echo experiments will provide further data on particle acceleration and loss mechanisms and wave–particle interactions in the magnetosphere. (Diss. Abstr. Int., B)

12961 SHAPE OF THE EARTH MAGNETOSPHERE. Choe, J. Y. Lawrence, KS; Univ. of Kansas (1972). 201p. University Microfilms Order No. 72-32,870.

Thesis.

The shape of the magnetopause for various orientations of the solar-wind stream with respect to the Earth dipole axis has been calculated by a self-consistent method, in which the surface equation and the magnetic-field integration form one iteration. The surface is determined by the magnetohydrodynamic pressure-balance equation, and the magnetic field due to the surface currents on the boundary is obtained from Biot–Savart's law. The solar wind is assumed to have no random motions and to be free from magnetic fields, and the solar-wind particles are assumed to undergo specular reflections from the boundary. The procedure used here is in many ways similar to the method of Mead and Beard (for perpendicular incidence) and Olson (for oblique incidence). Improvements are, however, achieved in the present study by using finer grid near the neutral point and by including an analytic singularity calculation in the magnetic-field calculation. The result shows very excellent convergence in the surface equation and improved satisfaction of the boundary conditions. The solar-wind flow at the neutral point is tangential to the surface and the geocentric distance and the angle from the dipole axis of the neutral point decrease at a slower rate as the wind-dipole angle increases. The tail is nearly cylindrical and its axis is parallel to the stream direction. The displacement of the axis of the tail from the Earth-wind line increases as the wind-dipole angle increases. (Diss. Abstr. Int., B)

12962 STUDY OF THE SPATIAL DISTRIBUTIONS OF OFF-EQUATORIAL PROTONS AT L = 1.4 TO 1.8. Mickelson, L. Riverside, CA; Univ. of California (1972). 66p. University Microfilms Order No. 72-31, 495.

Thesis.

Multiple Coulomb scattering of inner-belt protons is shown to be negligible as a mechanism for redistribution. Random electrostatic waves with a correlation time on the order of the drift period of the protons are shown to be an effective radial diffusion mechanism for off-equatorial protons. The equatorial power spectrum for waves of magnitude 5 mV/m and correlation time of 30 seconds is shown to be 0.035 $(mV/m)^2Hz^{-1}$, within the limits of the experimentally derived power spectrum of 0.3 to 0.03 $(mV/m)^2Hz^{-1}$. (Diss. Abstr. Int., B)

12963 PLASMA IN LABORATORY AND OUTER SPACE. Sagdejew, R. Bild Wiss.; 9: No. 8, 818-27(1972). (In German).

A survey is given of the various aspects and implications of plasma physics, that is: controlled nuclear fusion, solar wind, earth magnetosphere, shock wave phenomena, plasma guns, artificial plasma clouds in the atmosphere and supraresistivity. (GF)

PHYSICS (ATOMIC AND MOLECULAR)

12964 (NP-19424) 1971 ANNUAL REPORT. (Stichting voor Fundamenteel Onderzoek der Materie, Utrecht (Netherlands). Stichting Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 1971. 219p. (In Dutch). Dep. NTIS (U. S. Sales Only).

The principal experimental and theoretical investigations are summarized. Studies on the properties of three-nucleon systems and nucleon–nucleon interactions are summarized. Recent developments in surface studies with low energy ions are reported. These include the determination of the topography of crystal surfaces by means of multiple impacts, determination of the elementary composition of the surface by means of single impacts, and chemical analysis of the surface by means of secondary ion emission. Apparatus for the simultaneous measurement of topography, composition, and crystal orientation of surfaces was developed. In studies on the kinetic gas theory of multiatom gases, various transport equations describing nonequilibrium dilute gases were reviewed. The need for a more phenomenological or semi-empirical description in the physics of condensed matter is illustrated by the presentation of a simple model for stability of metallic alloys. An introduction is given to a method of investigating kinetic processes in molecular gases, which is based on the spectroscopic observation of the disturbance in population of specific energy levels resulting from a strong infrared or microwave pump field. Dynamics of spin systems in solids were studied. The problems and possibilities in the heating and confinement of plasma by the toroidal diffuse pinch (Tokamaks) are summarized. Studies done in collaboration with MIT on the Alcator are reported. Publications made by each of the divisions are tabulated. (JSR)

Beams and Their Reactions

Refer also to abstracts 11956, 11957, 13834, and 13905.

12965 (ANU-P-560) FURTHER EVIDENCE AGAINST A CHANNELING EFFECT IN THE OPTICAL EXCITATION OF ION BEAMS TRANSMITTED THROUGH SINGLE CRYSTALS OF GOLD. Newton, C. S.; MacDonald, R. J.; Sofield, C. J.; Hay, H. J. (Australian National Univ., Canberra). 1971. 6p. Dep. NTIS (U. S. Sales Only).

The intensity and polarization of light emitted by He^+ ions excited by transmission through a single-crystal gold film were studied for the case when the He^+ ions are incident close to a ⟨111⟩ channel. No evidence for a channeling effect was observed. (auth)

12966 ASSOCIATIVE DETACHMENT REACTIONS. Mauer IV, J. L. New Haven; Yale Univ. (1972). 111p. University Microfilms Order No. 72-31,451.

Thesis.

The associative detachment reactions of O^- with CO, H_2, and O_2 are studied experimentally using an ion beam (0 to 10 eV) impinging on a gas-filled chamber. The resultant electrons are energy analyzed using retarding potentials. At low ion energy, cross sections for total electron detachment for the reactions of O^- with CO and H_2 vary as the inverse of the relative velocity. At higher energies, the cross sections show a broad peak. This shape is interpreted in terms of the potential energy curves of the compound states. The electron energy distributions for the reactions of O^- with CO and H_2 exhibit peaks at low energy corresponding to the excitation of high vibrational and rotational states of the resultant molecule. Progressions observed in these distributions have spacings corresponding to the preferential excitation of the bending modes resultant triatomic molecules. The cross section for total electron detachment for the reaction of O^- with O_2 exhibits a threshold near 0.7 eV and rises linearly at higher energy. (Diss. Abstr. Int., B)

12967 POTENTIAL ION–ELECTRON EMISSION OF MOLYBDENUM UNDER THE ACTION OF MULTICHARGED ARGON IONS. Arifov, U. A.; Rakhimov, R. R.; Radzhabov, Sh. S.; Mavlyanov, A. N. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 6, 19-21(1971). (In Russian).

The coefficients of kinetic electron emission and of potential electron emission for bombarding Mo with Ar^+ to Ar^{7+} were investigated as functions of the velocity and charge in the energy range 2 to 20 keV. The multicharged ions were obtained by ionization of Ar by a 3-keV electron beam. Ion velocities varied from 1.1 to 4×10^7 cm/sec. The basic components of the apparatus were the ion source, a mass spectrometer, a receiver with the target, and a spherical collector. (KSW)

12968 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 7, NO. 10, 1972. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 61p.

This listing contains 195 references on various aspects of surface and vacuum physics. (MOW)

12969 SECONDARY ION EMISSION FROM A TUNGSTEN–MOLYBDENUM ALLOY UNDER THE INFLUENCE OF SLOW IONS. Gruich, D. D.; Khamidova, Kh. M.; Ermakov, G. E.; Arifov, U. A. pp 1-2 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Secondary ion emission coefficients were measured for a 50% W–Mo alloy as a function of the energy (15 to 500 eV) of Na^+ ions and target temperature. The secondary ions were separated into elastically scattered and slow ions. Changes in the coefficients are discussed with respect to the formation of a Mo film on the surface. (DLC)

12970 POTENTIAL EMISSION OF ELECTRONS FROM THE (110) AND (111) FACES OF A MOLYBDENUM SINGLE CRYSTAL UNDER ION BOMBARDMENT. Arifov, U. A.; Rakhimov, R. R.; Dzhurakulov, Kh. pp 6-9 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The emission coefficient γ and energy distribution of the electrons were measured for the (110) and (111) faces of a Mo single crystal bombarded by He^+ or Ar^+ ions at 0.2 to 1.2 keV. For low energies, γ is independent of the incident ion energy, indicating that the emission is of the potential type; $\gamma_{\pi(110)} = 25.5\%$ and $\gamma_{\pi(111)} = 28\%$ for He ions, and $\gamma_{\pi(110)} = 8\%$ and $\gamma_{\pi(111)} = 12\%$ for Ar ions. The energy distribution curves show two maxima for He^+ ions; the crystallographic direction has a considerable effect on the distribution. (DLC)

12971 ELECTRON EMISSION OF THE (110) AND (111) FACES OF A MOLYBDENUM SINGLE CRYSTAL ON BOMBARDMENT WITH HELIUM AND ARGON IONS AND ATOMS. Arifov, U. A.; Rakhimov, R. R.; Dzhurakulov, Kh. pp 10-15 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A study was made of the electron emission coefficient and energy distribution in Mo (110) and (111) faces bombarded with He and Ar ions and atoms at 0.2 to 5 keV. The results show that the kinetic emission of electrons is very much the same for both ions and atoms, while the potential emission varies only slightly with ion velocity, and the energy spectrum of the electrons emitted by the potential mechanism changes appreciably with ion velocity. (DLC)

12972 NEGATIVE-ION SPUTTERING OF SILVER ON BOMBARDMENT WITH Cs^+ IONS. Abdullaeva, M. K.; Ayukhanov, A. Kh. pp 16-18 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The mass spectrum of the negative ions emitted in the bombardment of Ag by Cs^+ ions at 500 to 2000 eV was studied. The relation between the yield of Ag^- and CN^- ions and the incident ion energy was determined; the Ag^- yield increases linearly with energy, while that for CN^- falls to an equilibrium value. The results are compared with those of Bradley and Ruedl for Cu sputtered by Ar^+ ions. It is concluded that the Ag^- ions are the result of cathodic sputtering of the principal element. (DLC)

12973 NEGATIVE-ION SPUTTERING OF TUNGSTEN BOMBARDED WITH ALKALI METAL IONS. Shustrov, V. A.; Ayukhanov, A. Kh. pp 19-23 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The radioisotope ^{185}W was used in a study of the cathodic sputtering of a W foil by Cs^+, Rb^+, K^+, and Na^+ ions at 800 to 2500 eV. Negative-ion sputtering coefficients and ratios were studied as functions of energy and retarding potential. At ~1000 eV, about half of the ejected particles are negative ions of tungsten–oxygen compounds. The mechanism for ejection of molecules is discussed and equations derived for the ejection energy. Effects of changing the ion current density were studied. (DLC)

12974 SECONDARY-ELECTRON EMISSION FROM SURFACES OF GERMANIUM AND SILICON ON BOMBARDMENT WITH ALKALI IONS. Turmashev, E.; Ayukhanov, A. Kh. pp

24-6 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Coefficients γ of ion–electron emission were measured for Ge and Si single crystals bombarded by Li, Na, K, Rb, and Cs cations. Ge bombarded by Ga^+ ions was also investigated. γ increases linearly with energy above a threshold energy and is greatest for Na^+ ions on Si and Ga^+ and K^+ ions on Ge. A plot of γ vs incident ion mass indicated that the maximum γ values are obtained when the mass is close to that of the target atoms. (DLC)

12975 SECONDARY EMISSION OF NEGATIVE PARTICLES FROM NiCr AND CuBe ALLOYS. Khadzhimukhamedov, Kh. Kh.; Makhmudov, A. Kh.; Ayukhanov, A. Kh. pp 27-9 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Results are presented of an investigation of the secondary emission coefficients of electrons (γ) and negative ions (K_-) from NiCr and CuBe alloys bombarded with Na^+, K^+, and Cs^+ ions at $E_0 = 400$ to 1400 eV. Plots of γ and K_- vs E_0 show that the contribution of negative ions to the secondary emission is considerable, being dominant for Cs^+ on NiCr. The value of γ and its slope on the E_0 plot are greater for the light ion K^+ than for the heavy ion Cs^+. (DLC)

12976 SECONDARY ELECTRON EMISSION OF NiCr AND AlBe ALLOYS. Arifov, U. A.; Khadzhimukhamedov, Kh. Kh.; Makhmudov, A. Kh. pp 30-2 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Data are presented for secondary electron–electron emission σ from NiCr and AlBe alloys for primary electron energies E_0 of 200 to 1200 eV. For NiCr, σ reaches a maximum (~4 to 5) at $E_0 = 500$ eV, and increasing the incident angle to 45° and activation in a vacuum at 1300°K both increases σ. The same peaking effect at $E_0 = 500$ eV was observed, only more so ($\sigma \sim 18$) for bombardment by Na^+ ions. Similar results were obtained for AlBe alloy. (DLC)

12977 ISOTOPIC EFFECT ASSOCIATED WITH KINETIC ION–ELECTRON EMISSION. Mukhamadiev, E. S.; Mirzaev, A.; Rakhimov, R. R. pp 33-6 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A study was made of the isotopic effect in the bombardment of the (100) and (111) faces of a Si single crystal with ^{20}Ne and ^{22}Ne ions at 0.5 to 5.0 keV. In the low-energy range, the total emission coefficient γ is the same for the two ions. The kinetic emission coefficient γ_k is also plotted versus ion velocity; γ_k is different for ^{20}Ne and ^{22}Ne, and the difference $\Delta\gamma$ becomes smaller with increasing ion velocity. The anisotropy of γ in the (100) and (111) faces is also discussed. (DLC)

12978 ANGULAR DEPENDENCE OF ENERGY SPECTRA OF SECONDARY IONS SCATTERED BY A SINGLE CRYSTAL. Arifov, U. A.; Aliev, A. A. pp 37-42 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The angular and energy dependences of the maximum energies of secondary ions scattered by a Mo single crystal as a result of one, two, and more collisions, were studied. The secondary-ion spectrum from a Mo (100) face bombarded by Rb^+ ions shows doubly scattered ions at atoms in the [010] and [021] directions. Changes in energy spectra were determined for primary ion energies from 25 to 1000 eV. K^+ ion bombardments and the effects of different incident angles were also studied. (DLC)

12979 EFFECT OF STATE OF SUBSTRATE ON SECONDARY EMISSION OF DIELECTRIC FILMS SUBJECTED TO ION BOMBARDMENT. Arifov, U. A.; Rakhimov, R. R.; Gaipov, S. pp 43-6 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

A study was made of the effect of the state (clean or oxidized) of MO substrate on the electron and positive- and negative-ion emission from NaCl films under bombardment by Ar^+ ions at 50, 100, and 1000 eV. Emission coefficients were measured as functions of film thickness. Potential and kinetic emissions were separated. Results show that the coefficient of potential electron emission is independent of the substrate state, while the negative ion emission depends very strongly on it for small film thicknesses. Both coefficients of positive and negative ion emissions reach a maximum at a thickness of 1 or 2 monolayers, and thereafter reach low saturation values. (DLC)

12980 ADHESION (BINDING) OF ADSORBED ATOMS IN THE ION BOMBARDMENT OF CLEAN SURFACES. Radzhabov, T. D. pp 47-51 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Results of thermal desorption studies of inert gases from Ti films bombarded with inert gas ions are presented. The desorption curves show two peaks, particularly for the heavy ions, and only one peak for He. Desorption heats are calculated for the various inert gases on Ti films and for Ar on sputtered, compact, coarse-crystalline, and single-crystalline Ti. The mechanism and a model of the sorption of inert gas ions by metals are discussed. (DLC)

12981 SECONDARY EMISSION OF THIN FILMS ON PASSING IONS OF CERTAIN ALKALI METALS THROUGH THEM. Ablyaev, Sh. A.; Dzhemilev, N. Kh. pp 60-4 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Secondary-electron emission and its energy spectrum were studied using transmission of Li^+, Na^+, and K^+ ions through various thin films (KCl, MgO, Ni, Al). The emission coefficient γ increases linearly with ion energy at 10 to 30 keV, whereas the electron energy distribution is unaffected by it. The width of the distribution curve depends on the film material. 12 references. (DLC)

12982 ENERGY DISTRIBUTION OF SECONDARY-ELECTRON EMISSION. Arifov, U. A.; Kasymov, A. Kh. pp 79-82 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The secondary-electron energy spectrum was analyzed using a method based on spherical and cylindrical condensers. Results confirmed the importance of cleaning the target surface. The following metals were studied: Ti, Fe, Ni, Zr, Mo, In, Sn, Ta, W. Auger electrons, diffraction effects, electron-gas effects, and inelastic scattering are discussed. (DLC)

12983 EFFECT OF MULTIPLE SCATTERING AND THERMAL VIBRATIONS ON THE REFLECTION OF IONS FROM THE FACE OF A SINGLE CRYSTAL. Parilis, E. S.; Turaev, N. Yu.; Kivilis, V. M. pp 83-6 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The theory of the effect of thermal vibrations of the lattice atoms on the twofold collision peaks in the ion reflection spectrum is discussed. Calculations are made for the multiple scattering of 30-keV Ar^+ atoms from the (110) chain of Ni. Calculated peaks for $\theta = 30$, 35, and 40° are compared with experimental values. The contraction of the reflected beam due to multiple scattering and heating is shown. (DLC)

12984 PRODUCTION OF AN INTENSE ATOMIC BEAM OF BARIUM IN METASTABLE STATES. Ishii, S.; Ohlendorf, W. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Rev. Sci. Instrum.; 43: No. 11, 1632-5(Nov 1972).

A device for producing an intense atomic beam of barium in metastable states has been developed. The population density of the states is measured by the resonance fluorescence method. The atoms are excited by an electric discharge in such a way that the atomic beam traverses the discharge plasma. The cross section for excitation of barium by electron collisions is assumed to be as large as that for cesium. The efficiency of metastable atom production is estimated to be about 70%, and an atom flux of 4×10^{15} sec^{-1} cm^{-2} is obtained. The device is useful in forming a photoionized barium plasma using ordinary light sources. (auth)

Atomic and Molecular Properties

Refer also to abstracts 13510, 13526, and 13930.

12985 UNCONVENTIONAL BASIS SETS IN QUANTUM MECHANICAL CALCULATIONS. Bishop, D. M.; Leclerc, J. C. (Univ. of Ottawa). Mol. Phys.; 24: No. 5, 979-92(Nov 1972).

Recent years have seen the introduction of several new and sophisticated basis sets in quantum-mechanical calculations. Most applications of these basis sets have been to atomic systems, but since modern computing technology makes numerical integration a feasible alternative to analytical integration, they may be attractive for use in molecular calculations as well. Six of these sets, for approximating the ground-state wave-function of the hydrogen molecule, are investigated. On the basis of accuracy and computational time, it is concluded that the traditional Slater-type orbital (particularly with noninteger-n) still gives the best value. (auth)

12986 SIMPLE APPROACH FOR THE CALCULATION OF ENERGY LEVELS OF LIGHT ATOMS. Woodyard, J. R. Sr.

(Univ. of Nevada, Reno). Amer. J. Phys.; 40: No. 9, 1231-8 (Sep 1972).

Considerable insight into elementary atomic theory is generated by constraining the atomic Hamiltonian of atoms with few electrons by demanding that the electrons be as far apart as possible. This and other simplifying assumptions allows one to separate Schroedinger's equation by reducing the problem to a geometrical analog. The analogous problem is to locate dots symmetrically on the surfaces of concentric spheres consistently with the Pauli principle and with the dots as far apart as possible. The resulting equations permit calculation of effective nuclear charges, which are used to find the total energy of the system from a hydrogen-like energy formula. The energies so determined are compared to experimental values, and derived screening terms are compared to those of Slater's rules. The energies calculated are consistently lower than experimental values. (auth)

12987 DISSOCIATION ENERGIES OF MgO AND BeO MOLECULES. Rai, Badri; Rai, S. N. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 10: No. 5, 401-2(May 1972).

The dissociation energies of BeO and MgO were evaluated by fitting the electronegativity potential energy function to the experimental potential energy curves of these molecules. The dissociation energies thus obtained are compared with the values reported earlier. The ionicity of the bands is discussed in the light of these calculated values. (auth)

12988 HOLTSMARK'S $5/2$ POWER LAW FOR THE WINGS OF STARK-BROADENED HYDROGEN LINES. Griem, H. R. (Univ. of Maryland, College Park). Comments At. Mol. Phys.; 3: No. 4, 121-7(Jul 1972).

The broad wings of H lines from many stellar and laboratory spectra are known to be due to "intermolecular" linear Stark effects. Relatively high electric field strengths in the vicinity of a given atom are likely to be caused by a single perturbing ion or electron at some distance r from the atom, and if all dynamical effects can be neglected, there is a unique correspondence between r and the angular frequency perturbation. This leads to Holtsmark's asymptotic line shape. Three conditions for the validity of the $5/2$ power law are discussed. (UK)

12989 MOLECULAR EXCITATION BY POLARIZATION FORCES IN H ON H_2 COLLISIONS. Ioup, J. W. Storrs, CT; Univ. of Connecticut (1972). 141p. University Microfilms Order No. 72-32,223.

Thesis.

In order to calculate cross sections for atomic and molecular scattering in the intermediate energy range of 1100 keV, Russek has developed a hybrid approximation. In this approximation the nuclei are treated in the usual Born approximation and the electrons in the adiabatic approximation. This work contains the application of the Russek hybrid approximation to the collision between an atom and a homonuclear diatomic molecule. Vibrational and rotational excitation of the molecule is predicted as a result of polarization-induced forces caused by the presence of the atom. The form of the analytical expression for the interaction potential used in the calculations of the cross sections is discussed. A Legendre polynomial expansion is made of the potential with coefficients containing exponential and van der Waals interaction terms. Several unspecified parameters are included. An analytical expression for the potential for three hydrogen atoms was obtained by fitting these parameters to an ab initio calculation of the H_3 surface from the literature. The interatomic force in the molecule caused by the presence of the atom and the force between the atom and the molecule are derived from the analytical form chosen for the potential. The corresponding forces for the $H-H_2$ system are calculated using the parameters obtained for the H_3 potential. Expressions for the differential and total cross sections as functions of the potential parameters are derived for elastic scattering and for inelastic scattering when the final state of the molecule is either the ground rotational state in the first excited vibrational state or the first excited rotational state allowed by the collision in the first excited vibrational state. Hydrogen atom–hydrogen molecule scattering is presented as an example and differential and total cross sections computed. (Diss. Abstr. Int., B)

12990 PREQUENCH LOSSES IN H(2S) CROSS SECTION MEASUREMENTS. Wooten, J. W. (Univ. of Nebraska, Lincoln). Rev. Sci. Instrum.; 43: No. 12, 1833-4(Dec 1972).

A calculation of the fraction of incoming H(2S) atoms that decay to the ground state due to the fringing fields near a quench capacitor is done for several quench geometries. Under some possible experimental conditions, the prequench losses can be appreciable and experiments should be designed to avoid these conditions or correct for them. (auth)

12991 OPERATOR DOMAIN PARADOX AND THE RELATIVISTIC CORRECTION TO ENERGY LEVELS. Lieber, M. (Univ. of Arkansas, Fayetteville). Amer. J. Phys.; 40: No. 9, 1335-6 (Sep 1972).

It has been frequently emphasized that proper caution must be exercised in dealing with the unbounded operators occurring in quantum mechanics in order to avoid error and confusion. In particular, the domain on which an operator is defined may be larger than the domain on which it is Hermitian. The purpose of this note is to point out that a striking example of this apparently anomalous behavior occurs in a quite familiar and practical problem about which false or misleading statements exist in the literature. The example is the problem of calculating by means of lowest-order perturbation theory the shift in the energy levels of hydrogen, owing to the relativistic variation of mass with velocity. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 13166 and 13223.

Collision Phenomena

Refer also to abstracts 12654, 13450, and 13800.

12992 (NP-19621) ATOMIC COULOMB EXCITATIONS BY HEAVY, CHARGED PARTICLES. Report No. 39. Hansteen, J. M.; Mosebekk, O. P. (Bergen Univ. (Norway). Dept. of Physics). Dec 1971. 46p. Dep. NTIS (U. S. Sales Only).

Recent experimental results have necessitated further studies of atomic Coulomb excitations induced by heavy, charged projectiles such as protons, deuterons, alpha particles, etc. The earlier semiclassical model (the SCA model) was applied in the adiabatic as well as the diabatic projectile energy region. Impact parameter dependencies and total cross sections are evaluated and discussed for various electron shells. (auth)

12993 LUMINESCENCE DECAY TIME OF AIR AND NITROGEN–OXYGEN MIXTURES EXCITED BY ALPHA PARTICLES. de Chaffaut, F. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 112-18(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A systematic study of nitrogen luminescence decay time was performed, in which nitrogen was excited by α particles in various oxygen mixtures and air near atmospheric pressure. Results obtained by varying the oxygen ratio from 0 to 20% and total pressure from 200 to 2000 torr are given and explained by kinetic theory of the phenomena. It seems that a resonance collision process is responsible for the changes in the decay times of the second positive nitrogen group. An extrapolation of the measurements gives a decay time of 0.52 ns for air at atmospheric pressure. The luminescence decay time of air excited by the alpha particles from ^{210}Po was studied in a pressure range between 200 and 2000 torr. As is known, nitrogen is mainly responsible for the luminescence of air irrespective of the excitation method; the most intense bands emitted correspond to transitions of the second positive system of the N_2 molecule and the first negative system of the once-ionized molecule N_2^+. Between 220 and 600 nm, the spectral domain of these experiments, the presence of oxygen is shown by a strong inhibition of the intensity of the nitrogen bands and by the appearance of the auroral line OI at 557.7 nm, a line whose intensity is always very small. Therefore, the luminescence decay time of the air and that of a mixture containing 80% nitrogen and 20% oxygen were compared. Then the de-energizing mechanisms of the nitrogen molecules in the presence of oxygen were systematically studied for various oxygen contents and pressures. These results may be interpreted by a kinetic study of the phenomena and by the determination of the resonance collision process between the nitrogen molecules excited in the $C\ ^3\Pi\ u$ state and the oxygen molecules. (auth)

12994 STIMULATED COLLISION PROCESSES. Froehlich, G.; Sewing, K. H. (Univ., Stuttgart). Z. Naturforsch.; 27a: No. 11, 1558-63(Nov 1972). (In German).

Similar to the stimulated emission in radiation processes there are stimulated collisions in collision processes too. These stimulated collisions do not lead to an amplification of the electron transitions, as in radiation processes, but attenuate the transitions. So the occurrence of the stimulated collisions can stabilize the population density of the levels. (auth)

12995 EFFECT OF SELECTIVE COLLISIONS ON THE VELOCITY DISTRIBUTION OF ATOMS AND ON NONLINEAR INTERFERENCE EFFECTS. Kol'chenko, A. P.; Pukhov, A. A.; Rautian, S. G.; Shalagin, A. M. (Inst. of Automation and Electrometry, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1173-93(Oct 1972). (In Russian).

The effect of elastic collisions on the velocity distribution of excited atoms located in an external electromagnetic field is investigated. A collision integral is employed that simultaneously takes into account strong collisions and scattering into small angles (selective scattering). It is shown that, along with the familiar Bennett "dip" in the velocity distribution, there may exist a collision "dip" due to selective scattering. The dependence of its parameters on pressure differs from that for the Bennett "dip." The shape of the Lamb dip and of the amplification line of a weak wave interacting with a strong field is analyzed for either the same transition or a shifted one. Collisions involving a change of velocity manifest themselves differently in two- and three-level systems. (auth)

12996 SOME FEATURES OF LARGE ANGLE ELASTIC ATOMIC SCATTERING OF INTERMEDIATE ENERGY ELECTRONS. Rumyantsev, V. V.; Morozov, Yu. A.; Libenson, B. N. (Leningrad Polytechnic Inst.). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1221-5(Oct 1972). (In Russian).

It is shown that the maxima of the coefficient of elastic reflection of intermediate-energy electrons from solid bodies previously observed on variation of the incident electron energy, is related to the singularity of the intermediate-energy electron scattering by separate atoms. The essence of the singularity is that the integral cross section for elastic scattering of intermediate-energy electrons into angles between $\pi/2$ and π possesses a maximum at a scattered electron energy that is characteristic of each element. A phase-shift analysis shows that the effect is due to an increase at a certain characteristic energy of the contribution of partial cross sections with nonvanishing orbital momenta. A correlation is established between the effect and the singularities of the angular distribution of electrons scattered into large angles in the vapors and gases of certain elements. Such singularities were previously observed in atomic collision physics. It follows from the experiments and theory that this property of atomic scattering is true for most elements of the periodic system. (auth)

12997 IONIZATION LOSS FOR HIGH-ENERGY ELECTRONS IN THIN TARGETS. O'Brien, J. T. Washington, DC; Catholic Univ. of America (1972). 99p. University Microfilms Order No. 72-26,252.

Thesis.

The most probable ionization loss for electrons in thin carbon, aluminum, and copper foils was measured at the National Bureau of Standards 150-MeV electron linac. Data have been taken for carbon thicknesses from 50 to 600 mg/cm^2, aluminum from 60 to 350 mg/cm^2, and copper from 60 to 120 mg/cm^2. Incident energies of 50 to 100 MeV were used. Elastically scattered electrons that had passed through the thin foils were momentum analyzed by the high-resolution electron spectrometer. Electrons elastically scattered from a very thin beryllium foil (<14 mg/cm^2) were used to accurately determine the energy of the incident beam. The measured value of most probable energy loss included contributions due to bremsstrahlung radiation, recoil of the target nucleus, and the energy profile of the incident beam. Subtraction of these effects, in order to obtain the ionization loss contribution, was considered in detail. Results of these measurements were found to be in good agreement with theoretical prediction and with the results of earlier experiments on thicker targets. The techniques developed for making these measurements were found to provide a useful method for in-beam determination of the thickness of scattering targets. (Diss. Abstr. Int., B)

12998 INELASTIC ENERGY LOSSES IN ARGON ION–KRYPTON ATOM COLLISIONS AT KILOVOLT ENERGIES. Del Boca, R. L. Storrs, CT; Univ. of Connecticut (1972). 92p. University Microfilms Order No. 72-32,212.

Thesis.

Single collisions of Ar^+ on Kr, at 15 to 230 keV incident ion energies and for scattering angles from 10 to 40 degrees, have been studied using coincidence techniques. The reaction $Ar^+ + Kr \rightarrow Ar^{+m} + Kr^{+n} + (m + n - 1)e$ was studied to measure the inelastic energy loss of the collision and the probabilities of ionization of the collision partners. In general the average inelastic energy loss of the reaction increased as either the incident particle energy or the scattering angle increased (from 86 eV at 15 keV, 10° to 3142 eV at 225 keV, 40°). The data show indirect evidence of an "active region" for distances of closest approach in the range 0.2 Å $\leq R_0 \leq$ 0.3 Å. Analysis of the ionization probability data showed a statistical independence in the charge state probabilities of the scattered and recoil ions throughout the range studied. Also, for a given inelastic energy loss, the average ionization state of krypton was greater than that of argon. A model was employed to determine the amount of inelastic energy lost by each partner of the collision. It estimated that the krypton ion contributed the major portion to the inelastic loss (about 63%) over the range studied. (Diss. Abstr. Int., B)

12999 DIFFRACTION OF ION BEAMS AT ATOMS. Beier, H. J. (Technische Univ., Berlin). Phys. Lett.; 42A: No. 4, 311-12(18 Dec 1972).

It is shown that observed extrema in the small-angle scattering of $^7Li^+$ ions (about 30 keV) at atoms have to be described by diffraction of the matter waves. A simple correlation is given for describing the positions of the extrema. (auth)

13000 ION–MOLECULE REACTIONS. VOLUME 1. Franklin, J. L. (ed.). New York; Plenum Publishing Corporation (1972). 394p. $26.00.

New techniques and more effective methods that supersede the limited continuous-extraction mass ion source used in the past are presented in two volumes in the study of the ion–molecule collision reactions in the gas phase. Following an introductory chapter, chapters include: Positive-Ion–Molecule Reaction Studies in a Single-Electron-Impact Source; Ion–Molecule Reactions by Photoionization Techniques; Negative–Ion–Neutral Reactions; Rate Constants and Cross Sections; Chemical Ionization Mass Spectrometry; and Higher-Order Reaction: Ion Clusters and Ion Solvation. References are listed at the close of each chapter. (J.C.W.)

13001 ION–MOLECULE REACTIONS. VOLUME 2. Franklin, J. L. (ed.). New York; Plenum Publishing Corporation (1972). 406p. $26.00.

In Volume II, to the study of ion–molecule collision reactions in the gas phase, contents of Volume I are reviewed. The chapters include: Flowing Afterglow Studies; Ion Cyclotron Resonance Spectrometry; Mass Spectra and Appearance Potentials Studied by Use of Charge Exchange in a Tandem Mass Spectrometer; Tandem Mass Spectrometric Studies of Ion–Molecule Reactions; Beam Studies of Ion–Molecule Reactions; Ionizing Collision Reactions of Electronically Excited Atoms and Molecules; Electrical Discharges; Ions in Flames; and Structure and Reactivity of Hydrocarbon Ions. References are listed at the close of each chapter. (J.C.W.)

13002 CHARGE CHANGING OF ENERGETIC HEAVY IONS IN GASES. Tonuma, T.; Kohno, I.; Miyazawa, Y.; (and others) (Inst. of Physical and Chemical Research, Wako, Japan). J. Phys. Soc. Jap.; 34: No. 1, 148-55(Jan 1973).

The electron loss and capture cross sections of carbon (σ_{45}, σ_{56}, σ_{65}) and of nitrogen ions (σ_{45}, σ_{56}, σ_{67}, σ_{76}) in H_2, He, N_2, Ne, Ar, Kr, and Xe gases were measured at energies of 3.5 to 7.5 MeV/nucl. As the result, it has been found that cross sections for singly electron loss of those energetic heavy ions agree nearly with a formula given by N. Bohr and generalized by I. S. Dmitriev who derived the formula for electron loss in a free collision approximation through a classical treatment, and that from the relation between the electron loss cross sections and the atomic number of gaseous medium Z_{med}, the shielding effect of target gas was observed obviously in the region of $Z_{med} \gtrsim 10$. Cross sections for electron capture could not fit to previous theories, but agreed well with the calculation derived by Urata and Watanabe recently using an impulse approximation. (auth)

13003 THEORY OF CHARGE EXCHANGE. Bransden, B. H. (Univ. of Durham, Eng.). Rep. Progr. Phys.; 35: No. 9, 949-1005(1972).

The development of the theory of charge exchange in collisions of ions with atoms or ions is described, paying particular attention to the work of the last decade. The successful approximations based on the impact parameter and classical path methods, suitable for low energy collisions, are treated in detail. For high energies, approximations that are completely satisfactory from a theoretical viewpoint do not exist, but both the Born approximation and the classical models of Gryzinski and Thomas are found empirically to reproduce many features of the observed cross sections and a discussion is given of the successes and limitations of these and related models. (auth)

13004 THEORY OF RESONANT SCATTERING. van Santen, R. A. (Rijksuniversiteit, Leiden). Physica; 62: No. 1, 51-83 (1 Nov 1972).

A theory is presented which describes the time development as well as the stationary properties of a quantum-mechanical system

with unstable discrete states. The formalism enables one to compare and extend the existing resonance theories, especially those of Fano and Feshbach. An important new condition is derived, which determines the character of the time development. If this condition is not satisfied a nonexponential and also nonoscillatory time decay in a many-resonance system may be observed. This behavior appears to be connected with a time delay which is predicted to be pulsed at equal intervals in the case of multi-channel scattering and a cross section which can be anomalously narrow. The new condition, which is a commutator relation between two matrices appears to be connected with the so-called "overlap" introduced by Mies. An expression is presented for the autoionization in the case of many resonances, which is a generalization of the well-known result of Fano for one resonance. (auth)

13005 AUGER IONIZATION OF ATOMS BY MULTIPLY-CHARGED IONS: MODEL OF TWO COULOMB CENTERS. Kishinevskii, L. M.; Parilis, E. S. pp 87-93 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

The Auger ionization of an atom A by an n-charged ion B^{n+} may occur in three ways: direct, preliminary one-electron charge exchange, and preliminary two-electron charge exchange. Estimates are made for the case where the ion B^{n+} is represented by a Coulomb center, $Z_B = 3$ (Li^{3+}) or 4 (Be^{4+}), and $Z_A = 2$ (He atom). Charge exchange, probabilities of Auger ionization, and energy spectra of the electrons are discussed. 20 references. (DLC)

Atomic Theory

Refer also to abstracts 13290 and 13326.

13006 CUSP CONSTRAINTS IN EXTENDED HARTREE–FOCK METHODS. Levy, M. (Johns Hopkins Univ., Baltimore). Chem. Phys. Lett.; 17: No. 4, 598-602(15 Dec 1972).

It is shown that a necessary condition for an extended Hartree–Fock wave function or a multiconfiguration SCF wave function to be optimum is for each occupied natural spin-orbital to satisfy the electron–nuclear cusp constraint. The wave function, accordingly, must conform to the same electron–nuclear cusp conditions that are required of an eigenfunction of the hamiltonian. Also, the cusp constraint must be fulfilled by each φ_i when $\Psi(1, 2, \ldots, N) = A\Pi_{i=1}^{N}\varphi_i(i)\Theta_{spin}$. It is demonstrated that different meaningful sets of cusp conditions may be obtained from different representions of the same wave function. Data in the literature associated with some constraints due to Goddard are scrutinized, and it is found that there exist some simple approximate relationships linking these constraints. A recent criticism of Goddard's constraints is shown to be invalid. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

13007 (AD-745854) CONVERSION OF A TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC COMPUTER CODE FROM CDC-6400 FORTRAN TO IBM 360/67 FORTRAN. Yager, C. S. (Naval Postgraduate School, Monterey, Calif.). Jun 1972. 215p. NTIS.

Thesis.

In a previous thesis a very general method for numerically solving two-dimensional, two-fluid magnetohydrodynamic equations was developed. A copy of the computer code was given to the Physics Department at the Naval Postgraduate School for conversion to the IBM 360/67 system presently in operation at the school. The paper is intended to be a users manual for this code. Numerous changes to the original code were required due to the inherent differences between the CDC and IBM machines. The conversion of this code as well as a complete understanding of its operation and logic was the goal in the preparation of the paper. (auth)

13008 HYDROMAGNETIC STABILITY OF THE HETEROGENEOUS SHEAR FLOW IN PRESENCE OF VARIABLE MAGNETIC FIELD. Puspak, S. N.; Srivastava, K. M. (Univ. of Jodhpur, India). Indian J. Phys.; 46: No. 2, 68-75(Feb 1972).

The stability of an incompressible, nondissipative, vertically stratified and perfectly conducting fluid in the presence of a variable magnetic field, depending on the vertical co-ordinate and applied in the streaming direction, is investigated. The results established are the following: (i) The radius of Howard's semicircle, in which complex wave velocity of an arbitrary unstable mode must lie, increases or decreases according as D^2F^2 is positive or negative. (ii) The condition for stability for disturbances of wave length λ is $[(g\beta_0/\lambda^2) + (1/\lambda^2)\{(S/2)\ (2\lambda^2 - D^2)F^2\}_{min}] \geq (U_{max} - U_{min}/2)^2$. (auth)

13009 ELECTROHYDRODYNAMIC STABILITY OF INSULATING LIQUIDS SUBJECTED TO A UNIPOLAR INJECTION. Atten, Pierre (CNRS, Grenoble, France); Moreau, Rene. J. Mec.; 11: No. 3, 471-520(Sep 1972). (In French).

The hydrodynamic stability conditions of dielectric insulating fluids subjected to electric fields are analyzed using the following assumptions: the fluid is not self-dissociable, the space charge results from a homogeneous injection at the positive electrode only, this injection being entirely autonomous and characterized by an independent parameter (the space charge density near the injecting electrode). The various methods employed accurately define the critical conditions for the general case of an arbitrary finite injection and for the two extreme cases of very weak and infinitely strong injection. (auth)

13010 VARIATIONAL FORMULATION FOR HYDROMAGNETIC STABILITY. Platten, J. K.; Rasse, D. Entropie; No. 45, 7-16(1972). (In French).

A variational formulation was established for the problem of an electrically conducting liquid layer heated from underneath and subjected to a homogeneous magnetic field applied in a direction parallel to the gravitational field. This variational formulation utilizes the concept of a local potential (a concept previously introduced by Prigogine and Glandsdorff). The numerical results obtained using this method for the stability exchange case are compared with the results obtained by Chandrasekhar. The agreement is very good. Thus it appears that reliable results can be obtained for rigid boundaries in the case of overstability. The numerical results are extrapolated and the overstability conditions for rigid boundaries are demonstrated to be the same as those obtained analytically by Chandrasekhar for the free boundaries. (auth)

13011 UNSTEADY MAGNETOHYDRODYNAMIC FLOW BETWEEN TWO POROUS AND PARALLEL PLATES. Mathur, A. K. (Univ. of Rajasthan, Jaipur, India). Indian J. Phys.; 46: No. 4, 165-71(Apr 1972).

Unsteady motion of electrically conducting, viscous, incompressible fluids between two porous parallel plates under a transverse magnetic field is considered. The upper plate was given a time-dependent velocity in its own plane which sets the fluid in motion. The constant rate of injection at the lower plate is equal to the rate of suction at the upper plate. Using the Laplace transform technique, an expression for the velocity is obtained. Two particular cases are considered: the upper plate is given (i) a uniform motion and (ii) an impulsive motion. The results are shown graphically. (auth)

13012 MHD FREE CONVECTION LAMINAR FLOW OF AN ELASTICO-VISCOUS FLUID ALONG AN INFINITE POROUS WALL. Sriramulu, A. N. (Indian School of Mines, Dhanbad, India); Malhotra, R. C. Indian J. Phys.; 46: No. 3, 101-8(Mar 1972).

Unsteady MHD free-convection laminar flow of slightly electrically conducting elastico-viscous fluid was studied. When a conducting fluid moves through the magnetic lines of force the positive and negative charges are accelerated in such a way that their average motion gives rise to an electric current $J = \sigma V \times B$, where $B = B_0 + b$. The quantity b, is the magnetic induction resulting from the electric current j, in the fluid. In the analysis b, is considered as a perturbation on the basis of field strength and negligible in comparison with B_0, i.e. $B_0 \gg b_0$. Expressions are obtained for the skin friction, rate of heat transfer, temperature at high- and low-frequency oscillation of the wall, and magnetic parameter. (auth)

13013 DIMENSION-THEORY DETERMINATION OF THE SEPARATION PARAMETER FOR AN INCOMPRESSIBLE MAGNETOHYDRODYNAMIC BOUNDARY LAYER. Vatazhin, A. B. High Temp. (USSR) (Engl. Transl.); 10: No. 2, 279-284(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 318-324 (1972).

A system of parameters, which determines the flow in some section of an incompressible magnetohydrodynamic boundary layer, is proposed. Using dimensional theory, the dimensionless behavior of the separation parameter for laminar and turbulent boundary layers of a conducting fluid situated in electric and magnetic fields, as well as for the case where the medium is injected across a fairing, is found. The correlation of some aspects of the dimensionless behavior with the results of an exact solution is verified. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

13014 UPPER LIMIT OF THE QUARK FLUX. Bosia, G. F. (CNR, Turin); Briatore, L.; Sitte, K. Nuovo Cim.; 12A: No. 4, 1025-37(21 Dec 1972).

An upper limit of the quark flux is derived by evaluating the detection efficiency of a quark telescope, taking into account losses due to the shower accompaniment arriving together with the quark. This is calculated under the assumption of quark production at rest in the c.m. system, and of two other models which permit only a more restricted energy transfer to the quarks. It is shown that, while in the c.m. production mode nearly all quarks produced are also detected, the others yield a much lower efficiency which decreases with increasing quark mass, and may be as low as 10^{-2} at $m_q = 20m_n$. Thus the limit of 10^{-10} particles/cm^2 sr s deduced from telescope experiments still permits the presence of a total quark flux of a few 10^{-9}, or perhaps up to 10^{-8}/cm^2 sr s. Except for the results of the Ohio State group, all other flux measurements reported up to now seem to be compatible with this upper limit. (auth)

13015 SEARCH FOR THE QUARK IN EXTENSIVE AIR SHOWERS, USING A COUNTER-CONTROLLED CLOUD CHAMBER. Evans, G. R. (Univ. of Edinburgh); Fancey, N. E.; Muir, J.; Watson, A. A. Proc. Roy. Soc. Edinburgh, Sect. A; 70: 143-53(1972).

A search is reported for the relativistic e/3 quark among the cores of Extensive Air Showers initiated by primaries with energies greater than 10^{14} eV. The detector is a high-pressure cloud chamber filled with helium at 28 atmospheres, and is counter controlled. The experimental conditions avoid the criticisms levelled at the McCusker experiment and are such that the tracks of e/3 quarks cannot be simulated by singly charged shower particles either through statistical variations in primary ionization or otherwise. The primary ionization density, measured using a gap-counting technique on post-expansion electron and muon tracks, is compared with predictions from the theory of Budini et al. (1960). The agreement achieved shows that the theory is a reliable foundation for methods of identifying quark candidates, and measuring charges. The experiment has been running for 5000 hours. No quark candidates have been found. With an acceptance angle of 0.3 sr and an area of 140 cm^2, this sets the upper limit of flux of e/3 quarks at 4×10^{-9} cm^{-2} sec^{-1} sr^{-1} with 95 percent confidence. The experiment is being continued. (auth)

Electromagnetic

Refer also to abstracts 12185 and 12307.

13016 (COO-3023-15) RECOIL PROTON POLARIZATION IN NEUTRAL PION PHOTOPRODUCTION BETWEEN 1000 AND 1800 MeV. Tanaka, N.; Castro, M. M.; Milburn, R. H.; Richards, W. B.; Rutherfoord, J. P.; Stearns, B. F. (Tufts Univ., Medford, Mass. Dept. of Physics); Deutsch, M.; Patel, P. M.; Tsipis, K. (Massachusetts Inst. of Tech., Cambridge). Jul 1972. Contract AT(11-1)-3023. 23p. (CONF-720954-5). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

Measurements are presented of the recoil proton polarization for π^0 production angles near 64° c.m.s. The steep angular dependence observed by others at lower energies persists to at least 1500 MeV, and the polarization crosses through zero near 63° over the entire 900 to 1600 MeV energy interval. Summary fits are made to available recoil proton polarization data, 950 to 1250 MeV, and are found to require terms of order $\cos^3\theta$, but no higher. (auth)

13017 (JINR-E13-6659) MAGNETIC MEASUREMENTS FOR π^--e EXPERIMENT AT 50 GeV. Gaevski, V.; Guzik, Z.; Kirillov, A. D.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 12p. Dep. NTIS (U. S. Sales Only).

A detailed description of the measurement apparatus, data taking, and subsequent data analysis for a set of magnetic measurements at the Dubna magnet SP-12 is presented. The magnet was used as a spectrometer in an experiment to measure the pion-charge radius performed at the 76-GeV proton synchrotron at the IHEP, Serpukhov. (auth)

13018 (NP-19622) COHERENT π^0-PHOTOPRODUCTION ON DEUTERIUM IN THE FIRST RESONANCE REGION. von Holtey, G.; Knop, G.; Stein, H.; Stuempfig, J.; Wahlen, H. (Bonn Univ. (West Germany). Physikalisches Institut). Nov 1972. 16p. (PIB-1-182). Dep. NTIS (U. S. Sales Only).

Differential cross sections for coherent π^0-photoproduction from deuterium were measured in the photon energy range from 240 to 400 MeV and for pion c.m. angles between 70 and 160°. The recoil deuterons were analyzed in angle and momentum by a magnetic spectrometer. The cross sections obtained were higher by a factor of about 2 compared with the results from Stanford, the only data available up to now in the first resonance region. Below the resonance the measured cross sections give a smooth extension to the low energy data from Glasgow and Orsay. (auth)

13019 (RI-72-8) OUTLINE OF THE EXPERIMENT $\gamma D \rightarrow \pi^- pp$ ON CALCULATOR VARIAN 620/i. Boucrot, J.; McGill, W. (Paris Univ., Orsay (France). Laboratorie de l'Accelerateur Lineaire). Oct 1972. 26p. (In French). Dep. NTIS (U. S. Sales Only).

In the course of the experiment studying the photoproduction of π^- on deuterium, realized recently with the Linear Accelerator, the produced particles were detected by proportional wire chambers. The registration of data could only be done with a computer. The outline of this experiment and the programming which allows one to carry out the acquisition of events on a magnetic band are described. (tr-auth)

13020 (UCLA-10-P-25-7(Rev.)) MEASUREMENT OF DIFFERENTIAL CROSS SECTIONS FOR RADIATIVE PION-PROTON CAPTURE IN THE SECOND RESONANCE REGION. Weiss, A. J.; Blasberg, D. J. (California Univ., Los Angeles); Crowe, K. M.; (and others) (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1972. Contract AT(11-1)-Gen-10. 29p. (CONF-720954-6). Dep. NTIS.

From sixteenth international conference on high energy physics; Batavia, IL (6 Sep 1972).

Preliminary results of a measurement made at the LBL Bevatron of differential cross sections for $\pi^- p \rightarrow \gamma n$, consisting of an excitation curve at $\theta_\gamma = 90°$ for eight pion-momenta between 500 and 900 MeV/c, and four angular distributions between 550 and 700 MeV/c are presented. The momentum range corresponds to 1370 to 1610 MeV total c.m. energy, which includes the $P_{11}(1470)$, $D_{13}(1520)$, and $S_{11}(1535)$ resonances. The data were obtained in the second of a three-phase program to obtain measurements of cross sections for inverse single-pion photoproduction from free neutrons. A point was taken near the previously published data to insure continuity. (auth)

13021 MEASUREMENT OF THE Ξ MAGNETIC MOMENT. Cool, R. L.; Giacomelli, G.; Jenkins, E. W.; (and others) (Brookhaven National Lab., Upton, NY). Phys. Rev. Lett.; 29: No. 24, 1630-4(11 Dec 1972).

A measurement of the magnetic moment of the Ξ^- hyperon yielded the value $\mu_\Xi = (-2.2 \pm 0.8)\mu_N$. The Ξ^- polarization averaged over the acceptance angle and the four-momenta at which data were taken was $\overline{P} = 0.30 \pm 0.05$. (auth)

13022 π^0 PHOTOPRODUCTION FROM NEUTRONS. Osborne, A. M. (Cornell Univ., Ithaca, NY); Brownam, A.; Hanson, K.; (and others). Phys. Rev. Lett.; 29: No. 24, 1621-4(11 Dec 1972).

The ratio of the cross section for $\gamma + n \rightarrow \pi^0 + n$ to the cross section for $\gamma + p \rightarrow \pi^0 + p$ at 4.7 and 8.2 GeV was measured. The measurements were made by detecting the recoil nucleons in coincidence with the decay γ rays of the π^0's produced from a deuterium target. At 4.7 GeV the cross-section ratio, $R \equiv \sigma(\gamma + n \rightarrow \pi^0 + n)/\sigma(\gamma + p \rightarrow \pi^0 + p)$, is less than 1.0 at low t, with an indication of a dip at about $t = -0.7$ (GeV/c)^2, and rises to 1.0 at high t. The ratios at the higher energy have less structure and are uniformly closer to 1.0. (auth)

13023 POLARIZATION OF RECOIL PROTONS FROM PROTON COMPTON SCATTERING IN THE REGION OF THE SECOND πN RESONANCE. Kabe, S. (Tokyo Univ.); Fujii, T.; Kamei, T.; (and others). Nucl. Phys.; B50: No. 1, 17-28(1972).

The polarization of recoil protons from proton Compton scattering was measured at an angle of 90° cms in the region of the second nucleon resonance. The scattered photons were detected by a telescope which consisted of a lead plate converter, scintillation-counter hodoscopes and a Cherenkov counter. The angles and momenta of recoil protons were analyzed by a magnet with

four spark chambers. The polarization of protons was obtained from the asymmetry in the elastic scattering of protons on carbon in a spark chamber. The polarization of recoil protons from proton Compton scattering are -0.36 ± 0.29 and -0.13 ± 0.29 at incident photon energies of 700 ± 50 and 800 ± 50 MeV, respectively. The polarization of recoil protons from neutral pion photoproduction is also obtained and the results are in good agreement with the previous data. A calculation of the polarization of recoil protons in the proton Compton scattering was made by using an isobar model. The results of the calculation are consistent with the experimental data. (auth)

13024 TRANSITION RADIATION IN THE OPTICAL DOMAIN PRODUCED BY 40- TO 60-MeV ELECTRONS TRAVERSING METALLIC FOILS. Wartski, L. (CNRS, Orsay, France); Marcou, J.; Papiernik, A.; (and others). Nucl. Instrum. Methods; 106: No. 1, 103-7(1973). (In French).

Optical transition radiation patterns produced by 40- to 60-MeV electrons passing through metallic foils was studied in connection with the multiple scattering effect. At small angles, a strong dependence, close to E^3, of the power radiated versus the energy of the electrons was measured. (5 figures) (auth)

13025 ELECTROPRODUCTION OF $\pi^-\Delta^{++}(1236)$ FROM HYDROGEN AT W = 1.9 GeV AND $-k^2 = 0.7$ GeV^2. Montgomery, H. E. (Univ. of Manchester, Eng.); Allison, J.; Dickinson, B.; (and others). Nucl. Phys.; B51: 377-87(1973).

Cross sections are presented for the electroproduction of the channel $\pi^-\Delta^{++}(1236)$ from hydrogen, i.e., for the virtual photoproduction process $\gamma_v p \rightarrow \pi^-\Delta^{++}(1236)$ at W = 1.9 GeV, $-k^2 = 0.7$ GeV^2 and with $\epsilon = 0.85$ for $\phi = 90°$, 135° and 180° and $0.2 < -t < 0.5$ GeV^2 ($0 < \theta^* < 45°$). Comparisons with the Born model of Berends and Gastmans and with the vector-dominance model of Bartl and Schildknecht are shown. There is reasonable agreement between models and data except for the t-dependence of the Born model. (auth)

13026 SINGLE PHOTOPRODUCTION OF NEUTRAL π-MESONS ON DEUTERIUM IN THE FORWARD DIRECTION AT 4 GeV. Braunschweig, W.; Dinter, H.; Erlewein, W.; (and others) (Technische Hochschule, Aachen). Nucl. Phys.; B51: 157-66 (1973).

The ratio $R = (d\sigma/dt)(\gamma d \rightarrow (\pi^0 n)p)/(d\sigma/dt)(\gamma d \rightarrow (\pi^0 p)n)$, was measured at the Deutsches Elektronen-Synchrotron DESY, Hamburg, at a mean photon energy of 4.0 GeV in the four-momentum transfer range between $t = -0.2$ (GeV/c)^2 and $t = -1.2$ (GeV/c)^2 in steps of approximately 0.08 (GeV/c)^2. The ratio R is less than 1 up to $t = -0.9$ (GeV/c)^2 and shows a broad minimum around $t = -0.6$ (GeV/c)^2. Corrections for nuclear effects in the deuterium were not applied but are shown to be small. (auth)

13027 SINGLE PHOTOPRODUCTION OF NEUTRAL π-MESONS ON HYDROGEN IN THE FORWARD DIRECTION AT 4 GeV. Braunschweig, W.; Erlewein, W.; Frese, H.; (and others) (Technische Hochschule, Aachen). Nucl. Phys.; B51: 167-73 (1973).

The differential cross section of the reaction $\gamma p \rightarrow \pi^0 p$ was measured at the Deutsches Elektronen Synchrotron DESY, Hamburg, at a mean photon energy of 4.0 GeV in the four-momentum transfer range between $t = -0.2$ (GeV/c)^2 and $t = -1.2$ (GeV/c)^2 in steps of approximately 0.08 (GeV/c)^2. The experiment was carried out in connection with the measurements of the photoproduction of π^0 mesons on deuterium, which were previously described. The contributions arising from background reactions are discussed in detail. (auth)

13028 INTERACTION OF PHOTONS WITH MATTER. Ting, S. C. C. (Massachusetts Inst. of Tech., Cambridge). pp 80-105 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

Recent experimental work on the interaction of photons with matter is reviewed. The review consists of three parts devoted to: the validity of quantum electrodynamics at distances of 10^{-14} – 10^{-15} cm (interaction of photons with electrons); leptonic decays of vector mesons (interaction of photons with photon-like particles); photoproduction of vector mesons (interaction of photons with nuclei). The review deals only with the most important and most recent experiments. A list and details of other similar experiments can be found in the Proceedings of the Vienna Conference. (auth)

13029 ANGULAR DISTRIBUTION OF PROTONS IN THE REACTION ^{6}Li(e,e'p)^{5}He AT ELECTRON ENERGY 1158 MeV. Antuf'ev, Yu. P.; Agranovich, V. L.; Kuz'menko, V. S.; Sorokin, P. V. JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 240-1 (20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 339-41(20 Sep 1972).

The angular distribution of protons knocked out by 1158-MeV electrons from the 1p and 1s shells of the lithium-6 nucleus was measured. The experimental data are compared with shell-model calculations with an oscillator potential. (J.F.P.)

13030 OBSERVATION OF MULTIHADRONIC EVENTS IN e^+e^- COLLISIONS AT THE ENERGY OF 1.18 TO 1.34 GeV. Kurdadze, L. M.; Onuchin, A. P.; Serednyakov, S. I.; Sidorov, V. A.; Eidelman, S. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 42B: No. 4, 515-18(25 Dec 1972).

By using the electron–positron storage ring VEPP-2, multipionic events were observed at a total energy of 1.18 to 1.34 GeV. The experimental cross section appears to be considerably larger than that calculated within the framework of the vector dominance model for the processes $e^+e^- \rightarrow \rho\pi$, $\rho\epsilon$, $\omega\pi$, $A_1\pi$. The data on the total cross section obtained in the framework of the statistical model with 4 pions are presented. (auth)

13031 ANGULAR DEPENDENCE OF THE ASYMMETRY OF THE CROSS SECTION FOR THE REACTION $\gamma p \rightarrow \Delta^{++}\pi^-$ AT A PHOTON ENERGY 650 MeV. Ganenko, V. B.; Gorbenko, V. B.; Zhebrovskii, Yu. V.; (and others) (Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 310-12(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 435-7(5 Oct 1972).

Measurements were made of the asymmetry of the cross section of the reaction $\gamma + p \rightarrow \Delta^{++} + \pi^-$ on a linearly-polarized beam of photons at an energy of 650 MeV, in the π^- emission angle interval of 45 to 120° in the c.m.s. The results are shown together with the theoretical calculations in the Born approximation. (L.B.S.)

13032 π^0 PHOTOPRODUCTION WITH POLARIZED BREMSSTRAHLUNG IN THE ENERGY RANGE 400 TO 900 MeV. Zdarko, R. W. Stanford, CA; Stanford Univ. (1972). 131p. University Microfilms Order No. 72-30, 727.

Thesis.

The asymmetry ratio $A = (\sigma_\perp - \sigma_\parallel)/(\sigma_\perp + \sigma_\parallel)$ was measured for the reaction $\gamma + p \rightarrow p + \pi^0$ using linearly polarized photons. For π^0 center of mass angle, $\theta_{cm} = 90°$, measurements were made for 18 different photon energies between 426 MeV and 878 MeV. For $\theta_{cm} = 60°$, measurements were made for 9 different photon energies between 628 MeV and 918 MeV. The Stanford Mark III electron beam was used to produce a partially polarized bremsstrahlung beam. This photon beam was used to photoproduce π^0 mesons from a liquid hydrogen target. The recoil protons from this reaction were detected and analyzed in a Panofsky type quadrupole spectrometer. The ratio R of the counting rates from this meson production perpendicular and parallel to the plane of photon polarization was measured for the above mentioned photon energies and π^0 centers of mass angles. The ratio R is related to the meson asymmetry A by $A = 1/P[(R-1)/(R+1)]$, where P is the calculated photon polarization. Considerable time was spent studying π-pair and "ghost proton" backgrounds so that their corrections to the data were well understood. The data points around 750 MeV were also measured using a coincidence set-up in which both the recoil proton and the decayed π^0 were detected. The polarization calculation was also extensively checked experimentally by measuring the asymmetry at one data point over and over again, but each time varying one or more of the experimental parameters involved in the calculation. These 27 measurements were compared to the phenomenological isobar-model theory of Walker and were in general in good agreement. (Diss. Abstr. Int., B)

13033 DIFFERENTIAL CROSS-SECTION MEASUREMENTS FOR π^0 PHOTOPRODUCTION IN THE REGION OF THE THIRD NUCLEON RESONANCE. Booth, P. S. L. (Univ. of Liverpool); Butler, M. F.; Carrol, L. J.; (and others). Nuovo Cim.; 13A: No. 1, 235-47(1 Jan 1973).

Differential cross sections were measured for π^0 photoproduction over the energy range 0.8 to 1.4 GeV and at angles between 50 and 90° c.m. (auth)

13034 ANALYSIS OF THE REACTION $\gamma + n \rightarrow p + \pi^-$ IN THE FIRST AND SECOND RESONANCE REGIONS. Rossi, V. (Univ., Rome); Piazza, A.; Susinno, G.; (and others). Nuovo Cim.; 13A: No. 1, 59-89(1 Jan 1973).

The final results of an experimental investigation of the reaction $\gamma + n \rightarrow p + \pi^-$ performed with a deuterium bubble chamber at the 1-GeV Frascati electrosynchrotron are presented. Total and differential cross sections on neutrons are extracted by means of the spectator model, the reliability of which has been checked by numerous tests and is extensively discussed. The problems of a

possible isotensor component in the electromagnetic current, the time-reversal invariance of the electromagnetic interactions and the photoproduction of the Roper resonance are considered in detail. (auth)

13035 PHOTODISINTEGRATION OF THE ^{12}C NUCLEUS BY 250 TO 1200 MeV γ QUANTA. Tonapetyan, S. F.; Goncharov, N. V.; Derebchinskii, A. I.; Konovalov, O. G.; Khvorostyan, V. M. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 6, 1955-60(Dec 1972). (In Russian).

The energy spectra of protons produced by photons of energies E_γ^{max} = 250, 293, 400, 600, 800, 1000 and 1200 MeV interacting with ^{12}C nuclei are presented. Protons with kinetic energies ranging from 70 to 240 MeV are recorded at an angle of θ_{lab} = 90° with a freon bubble chamber. These spectra are found to differ from those calculated on basis of the quasideuteron model. It is shown that the dependence of the differential cross sections ($d\sigma/d\Omega$, θ = 90°) on photon energy is different for photodisintegration of ^{12}C nuclei and deuterons. From an analysis of the experimental results it can be concluded that the dominant mechanism responsible for emission of protons at an angle θ_{lab} = 90° in the (γ,p) reaction for ^{12}C nuclei is π meson absorption. (auth)

13036 MEASUREMENT OF THE NUCLEAR-ELECTROMAGNETIC CASCADE DEVELOPMENT IN GLASS AT ENERGIES ABOVE 200 GeV. Gillespie, C. R.; Huggett, R. W.; Humphreys, D. R.; Jones, W. V.; Levit, L. B. (Louisiana State Univ., Baton Rouge). pp 1282-6 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The longitudinal development of nuclear-electromagnetic cascades with energies greater than 200 GeV was measured in a low-Z (glass) absorber. This was done in the course of operating an ionization spectrometer at mountain altitude in an experiment to study the properties of gamma rays emitted from individual interactions at energies around 10,000 GeV. The ionization produced by a cascade is sampled by 20 sheets of plastic scintillator spaced uniformly in depth every 2.2 radiation lengths. Adjacent pairs of scintillators are viewed by photomultipliers which measure the mean ionization produced by an individual cascade in 10 layers each 1.1 interaction length (4.4 radiation lengths) thick. The longitudinal development of the cascades was measured for about 250 cascades having energies ranging from 200 to 2500 GeV. The observations are compared with the predictions of calculations made for this specific spectrometer using a three-dimensional Monte Carlo model of the nuclear-electromagnetic cascade. (auth)

13037 STUDY OF COSMIC RAY MUON INTERACTIONS WITH SPARK-EMULSION CHAMBER. Yuda, T. (Kanagawa Univ., Yokohama, Japan); Mizutani, K.; Taira, K. pp 1423-8 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Showers produced by high energy cosmic ray muons were observed with spark-emulsion chamber at a depth of 40 m.w.e. underground. Results obtained, i.e., energy spectrum and zenith angle distributions of showers are presented. Furthermore, on the basis of experimental results, some possibilities of the detection of nuclear interactions of muons are discussed. (auth)

13038 LARGE ANGLE SHOWERS FROM MUON BREMSSTRAHLUNG. Kiraly, P. (Central Research Inst. for Physics, Budapest); Thompson, M. G.; Wolfendale, A. W. pp 1434-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

An analysis was made of the expected frequency of electron showers at large angles to the vertical arising from muon bremsstrahlung. Comparison was made with the observations of the Tokyo, Kiel, and Durham groups, and it is concluded that there is near agreement, so far as the burst size spectra are concerned, if allowance is made for uncertainties in recorded shower size. The only experimental results which do not appear to fit the muon bremsstrahlung model are those of Nagano et al., (1970) which refer to a class of large angle showers which have a high penetrating particle content. (auth)

13039 ZENITH ANGLE DISTRIBUTION OF HORIZONTAL AIR SHOWERS OF SIZES LARGER THAN 5,000. Boehm, E.; Nagano, M.; van Staa, R.; Truemper, J. (Univ., Kiel). pp 1438-43 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Horizontal air showers with zenith angles larger than 60° were analyzed. The amount of uncertainties in analysis is evaluated by simulating the detection process by Monte Carlo methods. The measured zenith angle distribution of showers of sizes between 5000 and 20,000 can be explained by the conventional model of pion decay, though the angular resolution is not good enough and statistics are too small to distinguish from other processes. The integral intensity of the showers of zenith angles larger than 80° is $(2.5 \pm 0.9) \times 10^{-13}$ cm^{-2} sec^{-1} ster^{-1} for shower sizes larger than 10,000 after the correction for the error in size determination. (auth)

13040 ELECTROMAGNETIC INTERACTIONS OF COSMIC RAY MUONS. Ayre, C. A.; Grupen, C.; Hamdan, M. A.; (and others) (Univ. of Durham, Eng.). pp 1447-51 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The electromagnetic interaction of muons in iron in the momentum range 8 to 500 GeV/c were studied using the Durham Spectrographic MARS. Single electron production from the knock-on process and showers of two or more electrons due to both pair production and the knock-on process were investigated. Preliminary results show relatively more showers initiated by positive than negative muons, the ratio being 1.34 ± 0.08, based on 1117 events. For single electrons, on the other hand, the ratio is 0.945 ± 0.041 based on 2363 events. (auth)

13041 SCATTERING OF HIGH ENERGY COSMIC RAY MUONS ON ELECTRONS. Allkofer, O. C.; Grupen, C.; Stamm, W. (Univ., Kiel). pp 1452-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Electromagnetic interactions of cosmic ray muons were investigated by a combined arrangement of the Kiel Horizontal Spectrograph and a spark chamber calorimeter. The different kinds of muon interactions were observed at muon energies up to 1 TeV and energy transfers in excess of 0.2 GeV. There is reasonable agreement between the experimental results and the theoretical predictions except for the knock-on process in the region of energy transfers around 1 GeV. In addition, the cross sections for positive and negative muons were compared over all ranges of muon energy and transferred energy. The preliminary results indicate that there is a positive-negative asymmetry in the cross section of the order of $\sigma_{\mu^+}/\sigma_{\mu^-} = 1.23 \pm 0.11$ in the considered energy range. This asymmetry cannot be explained by a normal behavior of the muon. The result is in contradiction to accelerator data on muon interactions. (auth)

13042 OBSERVATIONS OF VERY HIGH ENERGY SHOWERS INJECTED FROM BELOW HORIZON WITH EMULSION CHAMBER UNDERGROUND. Mizutani, K.; Mori, K.; Shirai, T. (Saitama Univ., Urawa, Japan). pp 1476-80 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

In the emulsion chamber exposed at an underground laboratory (μECC experiment), the showers above 1 TeV injected from below horizon were observed. Straightforward interpretations of these showers with the muon or the neutrino interaction are impossible. (auth)

13043 MASSIVE AND MASSLESS BOSONS COUPLED WITH THE LEPTON AND THE NUCLEON IN VIEW OF THE COSMIC RAY DATA. Mizutani, K.; Mori, K. (Saitama Univ., Urawa, Japan). pp 1481-6 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

Anomalies are searched for in the cosmic ray muon data at very high energies. Among others, a bremsstrahlung shower injected from below horizon (and perhaps two additional showers too) is strange from several reasons (Mizutani et al., 1971). The possibility of interpreting the event is inquired into the framework of the massive and massless boson theories. It is found that any scattering of a deep inelastic type (including a massive boson exchange instead of one photon exchange) hardly explains the data. Even the trident process cannot account the size of emission angle, if the shower is due to the secondary muon which does not experi-

ence an intermediate massive state during the collision of a nearly horizontal muon with a nucleon. The results are derived from simple kinematical analysis and they are valid in the single collision case. The possible cases are surveyed for the interpretation of the event. In this connection, the effects of the muon emission with a large momentum transfer on the deviation of the zenith angle distribution of cosmic ray muons from the normal one is studied at somewhat lower energy regions. The effect of the energy loss of a muon is also investigated. The probable size of the anomalous cross section is estimated to be less than 10^{-33} cm^2 in the single collision case. The larger cross section is also possible in the plural collision case, however the result is not unique for the specification of the nature of the event. (auth)

13044 RECENT PROGRESS ON TRANSITION RADIATION MEASUREMENTS AND ITS APPLICATION TO THE DETECTION OF ULTRARELATIVISTIC PARTICLES. I. THE FORMATION ZONE EFFECT. Yuan, L. C. L. (Brookhaven National Lab., Upton, NY). pp 1499-1504 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A detailed study of the "formation-zone" effect of the x-ray transition radiation was made which yields significant information on the coherent effect of this radiation when multi-GeV electrons traverse a series of thin foils or slabs of polystyrene foam. The dependence of the x-ray spectrum on the foil thickness, spacing and material was determined for incident electrons with the Lorentz factor, γ, varying from 2000 to 20,000. Comparisons with various theories were also made. (auth)

13045 MEASUREMENTS OF THE REACTION $\gamma p \rightarrow \varphi p$ WITH UNPOLARIZED BREMSSTRAHLUNG. Anderson, R. L. (Stanford Univ., CA); Gottschalk, B.; Gustavson, D. B.; (and others). Phys. Rev. Lett.; 30: No. 4, 149-52(22 Jan 1973).

The differential photoproduction cross section $d\sigma/dt$ was measured for the production of φ mesons as a function of t at a photon energy of 12 GeV from $|t| = 0.2$ (GeV/c)^2 to $|t| = 1.0$ (GeV/c)^2, and as a function of photon energy from 6 to 19 GeV at a $|t|$ of 0.6 (GeV/c)^2. These results, and all other world data, fall on a universal curve. The slope of the Pomeranchukon trajectory deduced from this experiment is $\alpha' = -0.03 \pm 0.13$. (auth)

13046 ELECTROPRODUCTION OF ρ AND φ MESONS. Dakin, J. T.; Feldman, G. J.; Lakin, W. L.; (and others). (Stanford Univ., CA). Phys. Rev. Lett.; 30: No. 4, 142-5(22 Jan 1973).

Measurements are reported of ρ^0 and φ electroproduction at 19.5 GeV in a wide-aperture spectrometer which detected the scattered electron and the decay products of the vector mesons. As $|q^2|$ increases, the ρ mass spectrum shape changes, the momentum-transfer distribution broadens, and the ratio of the ρ cross section to the total cross section decreases. The ratio of longitudinally to transversely polarized ρ^0 mesons is $0.45^{+0.5}_{-0.3}$ at $|q^2| = m_\rho^2$, and the interference between longitudinal and transverse amplitudes is almost maximal. The relative φ-meson cross section also decreases as $|q^2|$ increases. (auth)

Weak

13047 EXPERIMENTAL STUDY OF THE SELECTION RULE $\Delta S = \Delta Q$ IN K^0_{e3} AND $K^0_{\mu 3}$ DECAYS. Burgun, G. (CEN, Saclay, France); Lesquoy, E.; Muller, A.; (and others). Nucl. Phys.; B50: No. 1, 194-204(1972).

The time distribution of semi-leptonic decays of the neutral K meson produced in a hydrogen bubble chamber in the reaction $K^+p \rightarrow K^0p\pi^+$ with K^+ momenta between 1.2 and 1.7 GeV/c is studied. There are 306 $\pi e\nu$ decays and 74 $\pi\mu\nu$ decays, of known lepton charge with proper times between 0.04 and 20 K_S lifetimes identified. The results are compatible with no violation of the $\Delta S = \Delta Q$ rule. For the ratio x of the $\Delta S = \Delta Q$ amplitude to the $\Delta S = \Delta Q$ amplitude the values are found in K_{e3} decays: $\mathrm{Re}\ x_e = 0.05^{+0.07}_{-0.07}$ $\mathrm{Im}\ x_e = 0.08^{+0.06}_{-0.07}$, in $K_{\mu 3}$ decays: $\mathrm{Re}\ x_\mu = 0.10^{+0.13}_{-0.16}$ $\mathrm{Im}\ x_\mu = -0.03^{+0.1}_{-0.1}$. Assuming $\Delta S = \Delta Q$ the rate $\Gamma(K^0_L \rightarrow \pi e\nu + \pi\mu\nu) = (12.4 \pm 0.7) \times 10^6$ s^{-1} is found. (auth)

13048 DEPOLARIZATION OF NEGATIVE MUONS IN HELIUM AND NEON. Varlamov, V. G.; Dobretsov, Yu. D.; Dolgoshein, B. A.; Krillov-Ugryumov, V. G.; Rogozhin, A. M. (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 224-6(20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 318-20(20 Sep 1972).

The residual depolarization of negative muons in helium and neon in the gaseous state was measured. The polarization was determined by measuring the decay-electron asymmetry parameter at the Larmor precession of the muon spin in a magnetic field. (J.F.P.)

13049 DECAY MODE $^4H_\Lambda \rightarrow \pi^- + {}^3He + n$. Adamovic, O. (Inst. of Physics, Belgrade); Krecker, U.; Coremans-Berrand, G.; (and others). Lett. Nuovo Cim.; 6: No. 1, 9-12(6 Jan 1973).

A compilation of the results of experimental studies of the decay mode $\Lambda - {}^4H \rightarrow \pi^- + n + {}^3He$ made in the material accumulated by the European K^- collaboration is presented. The momentum distributions of the pion, neutron, and helium-3 are shown. Also a scatter plot of the total kinetic energy of the neutron and helium-3 in their center-of-mass system versus the cosine of the angle between the line of flight of the meson and helium-3 nucleus in the neutron–helium-3 center-of-mass system is given. (JFP)

13050 STOPPING MUON UNDERGROUND AT GREAT DEPTHS. Baschiera, B. (CNR, Turin); Bergamasco, L.; Castagnoli, C.; Picchi, P. pp 1378-83 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The results on the ratio of the stopping muons (energy 160 MeV) to the traversing muons obtained in the Mont Blanc Laboratory at 4270 hg/cm^2 with a liquid scintillator tank watched by 8 PMs are discussed. A two pulses sequence is accepted as a μ-e event only when seen contemporarily and identically by at least two PMs, discriminated against the low energy radioactivity pulses. The ratio results much higher than what predicted considering the contributions of atmospheric muons (even taking carefully in account the straggling) and of neutrino induced muons. A new process in which a soft component (muons or pions) is produced is considered. (auth)

13051 NEUTRON PRODUCTION IN LEAD BY MUONS OF MOMENTUM 1 TO 30 GeV/c. Hook, J. R.; Jenkins, I. A.; Turver, K. E. (Univ. of Durham, Eng.). pp 1429-32 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

The distribution in multiplicity of neutrons produced in lead by cosmic ray muons of known momenta in the range 1 to 30 GeV/c was measured using a device comprising an air gap magnet spectrograph and a modified IGY neutron monitor. The data which constitute an improvement in statistics over those presently available provide an estimate for the total photonuclear cross section which is compared with the conflicting values from earlier experiments and with theory. (auth)

13052 TOTAL RATE OF ENERGY LOSS OF COSMIC RAY MUONS IN IRON FOR THE MOMENTUM RANGE 5 TO 40 GeV/c. Ayre, C. A.; Hamdan, M. A.; Hume, C. J.; (and others) (Univ. of Durham, Eng.). pp 1458-62 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

A direct measurement was made of the total rate of energy loss of cosmic ray muons in iron for the momentum range 5 to 40 GeV/c with the new Durham spectrograph, M.A.R.S. The results agree, to within 2% at 6 GeV/c and 6% at 30 GeV/c, with prediction from the theory of ionization given by Sternheimer and Peierls, (1971) together with non ionization losses given by Hayman et al., (1963). (auth)

13053 OBSERVATION OF LARGE BURSTS USING AIR SCINTILLATION METHOD AND PROPORTIONAL COUNTERS. Takahashi, T. (Osaka City Univ.); Honda, K.; Oshima, M.; Shibata, H. pp 1463-7 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 4).

Bursts produced by high energy muons in rock were observed at a depth of 30 mwe underground by the use of two layers of proportional counters 30 cm apart, each consisting of 23 cylindrical proportional counters (diameter 10 cm, length 5 m) and by detecting fluorescence radiation from air with 16 DUMONT 6364 photomultipliers in the dark room (height 4 m, width 3 m, length 10 m). The size distribution of bursts obtained up to about 4000 particles by proportional counters agreed with the expected one. And air scintillations were observed for bursts of size above 1000 particles. (auth)

13054 BURST SIZE SPECTRUM OF COSMIC RAY MUONS AT LARGE ZENITH ANGLES. Chin, S. (Osaka City Univ.);

Higashi, S.; Kitamura, T.; (and others). pp 1468-74 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.4).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 4).

Bursts produced by high energy muons coming from large zenith angles were observed at a depth of 40 m.w.e. underground, using the similar apparatus as the one used for measuring the burst-size spectrum at the vertical direction. In an operating period of 2.0×10^4 hr and with an aperture of 21.6 m^2 str, 6400 events were detected within the range of 300 ~ 15000 particles. The correlation between the observed results of vertical muon bursts and that at large zenith angles is discussed. The results are so far consistent with the conclusion that the muons observed at sea level were produced mainly through the $\pi \rightarrow \mu$ decay processes. (auth)

13055 DECAY $\mu \rightarrow e + \nu + \bar{\nu}$ AND LIMITATIONS FOR MASSES OF THE NEUTRINO, W BOSON, AND VARIANTS OF WEAK INTERACTIONS. 2. ANALYSIS OF THE ISOTROPIC AND ANISOTROPIC PARTS OF THE ELECTRON SPECTRUM. Rekalo, A. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 1-8(Jan 1972). (In Russian).

The experimental data on the parameters of the isotropic (ρ,η) and anisotropic (δ,ξ) parts of the electron spectrum are analyzed by means of a general expression for the electron spectrum in the $\mu \rightarrow e + \nu + \bar{\nu}$ decay which was obtained previously. The restrictions for the constants of the vector and axial-vector interaction in muon and electron vertices are obtained. The experimental values of ρ and η permit the reasonable values of the W-boson mass to be obtained. The analysis of the ρ and η leads in certain cases to better values of the upper limit of ν-mass than those obtained in the direct measurements. (auth)

Strong (Baryon-induced)

Refer also to abstracts 13227 and 13404.

13056 (CONF-720954-8) CHARGED-PARTICLE PRODUCTION AT ISR. Technical Report No. 47. Lillethun, Endre (Bergen Univ. (Norway). Dept. of Physics). Nov 1972. 28p. Dep. NTIS (U. S. Sales Only).

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

Several research groups have measured cross sections for the production of charged particles at the CERN Intersecting Storage Rings (ISR) during the last year. At the ISR two proton beams of chosen momenta between 11 GeV/c and 31 GeV/c can be made to intersect each other in eight experimental regions under an angle of 15°. A review is given of such data mainly based on contributions from the Bologna-CEN/Saclay-CERN collaboration, the British-Scandinavian ISR collaboration, the CERN-Holland-Lancaster-Manchester collaboration and the Saclay-Strasbourg collaboration. In addition, data are presented from the Bucharest-CERN and the CERN-Cracow groups which have measured charged particle production by means of nuclear emulsions. With the difficulties in the measurement of absolute cross sections at the ISR it is very useful to have an overlap between different experiments. This is fulfilled for the SS and BS groups and for the BCC and CHLM groups. By running the ISR with different proton momenta in the two beams an overlap in the center of mass (c.m.) angles between the BS and the BCC groups can also be obtained. Measurements have been made on $\pi^{\pm}$, $K^{\pm}$ and $p^{\pm}$ production. In addition there are data from the CHLM group on production of positive particles for $x = p_l/p_{max}$ values up to 1. All groups have measurements for a value of transverse momentum, p_T, of 0.4 GeV/c which therefore gives an interesting overall view of production of particles at this p_T. Another special point of interest is the measurements of pion spectra of p_T up to 4 GeV/c by the SS-group. (JIW)

13057 (COO-1764-175) COMPARISON OF PION MOMENTUM DISTRIBUTIONS IN 19-GeV/c pp COLLISIONS WITH AND WITHOUT STRANGE-PARTICLE PRODUCTION. Marquit, Erwin (Niels Bohr Institutet, Copenhagen (Denmark)). Jun 1972. 12p. Dep. NTIS.

A comparison is made of the inclusive π^- momentum spectra for pp interactions at 19 GeV/c with V^0 and without V^0 (or any other strange-particle signal). It is found that the spectra for interactions with a V^0 and charged-particle multiplicity n correspond best to the spectra for interactions without a V^0 and multiplicity m2. (auth)

13058 (COO-3065-23) MEASUREMENT OF THE CHARGED-PARTICLE MULTIPLICITY IN pp COLLISIONS AT 102 GeV/c. Chapman, J. W.; Green, N. (Michigan Univ., Ann Arbor); Bromberg, C. M.; (and others) (Rochester Univ., N. Y.). 31 Aug 1972. Contract AT(11-1)-3065. 10p. (CONF-720954-7; UR-395; UMBC-72-11). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

Preliminary results from a sample of ~1200 events obtained from an exposure of the 30-inch ANL-NAL liquid hydrogen bubble chamber to 102-GeV/c protons are presented. The elastic and total inelastic cross sections are respectively 7.4 ± 1.0 mb and 32.8 ± 1.1 mb. The parameters of the multiplicity distribution for negative tracks are $\langle n_- \rangle = 2.19 \pm 0.07$, $D_-^2 = \langle n_-^2 \rangle - \langle n_- \rangle^2 = 2.54 \pm 0.12$, $f_2^- = D_-^2 - \langle n_- \rangle = 0.34 \pm 0.10$. (auth)

13059 (JINR-E1-6704) INVESTIGATION OF MULTIBARYONIC RESONANCES WITH STRANGENESS EQUAL TO AND DIFFERENT FROM ZERO. Shakhbazyan, B. A.; Timonina, A. A.; Kalinina, N. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 16p. Dep. NTIS (U. S. Sales Only).

The effective mass spectra of multibaryon systems with hypercharge Y = 0 to 6 are studied. The resonances were observed for the systems with hypercharge $Y \leq 1$: $(\Lambda\Lambda)$ and (Λp) only. (auth)

13060 (JINR-E1-6743) TOTAL ELASTIC p-p, p-d, p-n, CROSS SECTIONS IN THE ENERGY RANGE OF 1 TO 70 GeV. Beznogikh, G. G.; Buyak, A.; Nikitin, V. A.; Shafranova, M. G.; Sviridov, V. A.; Truong Bien; Vikhlyantseva, L. V.; Zayachki, V. I.; Zolin, L. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 12p. Dep. NTIS (U. S. Sales Only).

The total elastic p-p, p-d, and p-n cross sections measured at the Serpukhov accelerator and Dubna synchrophasotron are presented. (auth)

13061 (JINR-P1-6770) DETERMINATION OF THE AVERAGE MULTIPLICITY OF CHARGED PARTICLES IN p-p INTERACTIONS AT 35 GeV/c. Boguslavskii, I. V.; Viryasov, N. M.; Vyskochil, S.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results of an investigation of an average multiplicity of charged particles in p-p interactions at 35 GeV/c are presented. The analysis of possible errors in the multiplicity determination is carried out. (auth)

13062 EVIDENCE FOR THE ONSET OF SEMI-INCLUSIVE SCALING IN PROTON-PROTON COLLISIONS IN THE 50 TO 300-GeV/c MOMENTUM RANGE. Slattery, P. (Univ. of Rochester, NY). Phys. Rev. Lett.; 29: No. 24, 1624-7(11 Dec 1972).

Evidence is presented to support the onset, in the 50- to 300-GeV/c region of incident momentum, of the asymptotic prediction of Koba, Nielsen, and Olesen regarding the scaling behavior of the charged-prong multiplicity distribution in proton-proton collisions. Lower-energy data, typified by data at 19 GeV/c, are found not to demonstrate this limiting behavior. (auth)

13063 pp INTERACTIONS AT 303 GeV/c: MULTIPLICITY AND TOTAL CROSS SECTION. Dao, F. T. (National Accelerator Lab., Batavia, IL); Gordon, D.; Lach, J.; (and others). Phys. Rev. Lett.; 29: No. 24, 1627-30(11 Dec 1972).

In an exposure of the 30-in. hydrogen bubble chamber to a 303-GeV/c proton beam, 2245 interactions were observed. The measured total cross section is 39.0 ± 1.0 mb and the average charged particle multiplicity $\langle n_{ch} \rangle = 8.86 \pm 0.16$. (auth)

13064 METHOD FOR SEARCH FOR NUCLEON RESONANCES USING INTERNAL BEAM DURING ACCELERATION. Sannes, F.; Harrison, W. C. (Rutgers-The State Univ., New Brunswick, NJ). Nucl. Instrum. Methods; 105: No. 3, 541-3(1972).

A novel application of the missing-mass method is proposed which renders it possible to investigate the nucleon isobar mass spectrum using a variable-energy proton beam during acceleration. (2 figures) (auth)

13065 FORMATION STUDY OF $N\bar{N}$ INTERACTIONS BETWEEN 1.51 AND 2.90 GeV/c. I. TOPOLOGICAL AND REACTION CROSS SECTIONS. Eastman, P. S.; Ming Ma, Z.; Oh, B. Y.; (and others) (Michigan State Univ., East Lansing). Nucl. Phys.; B51: 29-56 (1973).

A systematic study of $\bar{p}p$ and $\bar{p}d$ topological and reaction cross sections between 1.51 and 2.90 GeV/c has been completed. The data have been analyzed in relation to the three known structures at c.m. $N\bar{N}$ energies of 2190, 2350, and 2375 MeV. The data suggest that four- and six-pion annihilations of antiprotons on neu-

trons may be the source of the 2350 MeV effect. Further data below 1.60 GeV/c are required to verify this tentative conclusion. (auth)

13066 FORMATION STUDY OF $N\bar{N}$ INTERACTIONS BETWEEN 1.09 AND 3.45 GeV/c. II. STRANGE PARTICLES. Oh, B. Y.; Eastman, P. S.; Ming Ma, Z.; (and others) (Michigan State Univ., East Lansing). Nucl. Phys.; B51: 57-76(1973).

A systematic study of $\bar{p}p$ and $\bar{p}d$ reactions producing strange particles between 1.09 and 3.45 GeV/c has been completed. Reaction and resonance cross-section data are presented at 11 $\bar{p}p$ and 13 $\bar{p}d$ momentum settings. Evidence for a broad shoulder in the $K\bar{K}$ 3π final state near 1.8 GeV/c is presented and contrasted to previously published work on a portion of the final data sample. No evidence for a $\bar{p}n \rightarrow K^0K^-\omega$ effect near 1.3 GeV/c is found, ruling out an association of $K\bar{K}\omega$ effects with the nearby isospin one enhancement in the total cross section. Finally, no evidence is found for a $\bar{p}p \rightarrow K\bar{K}\omega$ enhancement near 1.8 GeV/c. (auth)

13067 FORMATION STUDY OF $N\bar{N}$ INTERACTIONS BETWEEN 1.51 AND 2.90 GeV/c. III. RESONANCE PRODUCTION. Ming Ma, Z.; Eastman, P. S.; Oh, B. Y.; (and others) (Michigan State Univ., East Lansing). Nucl. Phys.; B51: 77-94(1973).

A systematic study of $\bar{p}p$ and $\bar{p}d$ resonance production cross sections in non-strange annihilation channels between 1.51 and 2.90 GeV/c has been completed. The data have been analyzed in relation to the three known structures at c.m. $N\bar{N}$ energies of 2190, 2350, and 2375 MeV. Several resonance intermediate states may have broad maxima near the isospin-one 2350-MeV structure. However, more data below 1.6 GeV/c are required to better describe the background in this region before firm conclusions may be drawn. (auth)

13068 LONGITUDINAL-MOMENTUM DISTRIBUTIONS FOR POSITIVE PARTICLES PRODUCED AT SMALL ANGLES IN PROTON–PROTON COLLISIONS AT A C.M. ENERGY OF 44.6 GeV. Albrow, M. G.; Barber, D. P.; Bogaerts, A.; (and others) (CERN, Geneva). Nucl. Phys.; B51: 388-96(1973).

Longitudinal-momentum spectra are presented for the production of K^+ and π^+ mesons at the CERN ISR at a transverse momentum of 0.8 GeV/c and a total c.m. energy of 44.6 GeV. Proton spectra for transverse momenta between 0.7 and 1.2 GeV/c are also given. The spectra cover a range of 0.2 to 1.0 in the Feynman variable $x = 2p_L/\sqrt{s}$. The π^+ spectrum agrees well with scaling when compared with accelerator data, while the K^+ spectrum is consistently above the scaling prediction. The proton spectra have pronounced peaks at x = 1, minima near x = 0.9 and broad maxima at x = 0.6. The data are compared with triple-Regge and diffraction dissociation models. (auth)

13069 DETERMINATION OF PARTIAL CROSS SECTIONS OF INELASTIC p + p INTERACTIONS FOR 10 GeV/c MOMENTA. Takibaev, Zh. S.; Boos, E. G.; San'ko, L. A.; (and others). Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 20-4(1972). (In Russian).

Methods for separating events and for determining the partial cross sections in p + p interactions where the initial momenta of the protons were 10 GeV/c were investigated. Identification of events was based on the magnitude of the deficient mass M_3^2 and on the confidence level of the observed hypothesis χ^2. The nature of the secondary charged particles for separating events along reaction channels was studied. Transitions between reaction channels were used to determine reaction cross sections. Mathematical simulation of the reactions under study aided in solving the problem. (tr-auth)

13070 ELASTIC SCATTERING OF PROTONS BY NUCLEONS IN THE ENERGY RANGE 1 TO 70 GeV. Nikitin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 2-38 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

Experimental method for studying high energy elastic scattering of protons by protons and nuclei are reviewed. The basic experimental results for pp and pd scattering for E > 1 GeV are given. The problem of checking dispersion relations for pN scattering is discussed. Models for high energy nucleon–nucleon interactions are reviewed. (J.F.P.)

13071 INFLUENCE OF NEUTRAL PARTICLES ON THE KINEMATIC EVALUATION OF THE INITIAL ENERGY. Boos, E. G.; Mukhordova, T. I.; San'ko, L. A.; Takibaev, Zh. S.; Temiraliev, T. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 32-5 (1972). (In Russian).

Various methods were used to calculate the Lorentz factor of the center-of-mass γ_c, and the influence of the neutral particles π^0 and n on this quantity is discussed. A total of 1,400 four-prong interactions were recorded with an 81-cm hydrogen bubble chamber, bombarded with 10-GeV/c protons. Best agreement with the anticipated value ($\gamma_c = 2.42$) was obtained after allowing for the nature and the true magnitudes of transverse momenta of the secondary particles. The presence of one or of several π^0-mesons did not affect the average value of the Lorentz factor, and the presence of a neutron led to a decrease in the average γ_c. (tr-auth)

13072 EFFECT OF TARGET PLACEMENT ON THE ANGULAR DISTRIBUTION OF SECONDARY PARTICLES RECORDED WITH A WILSON CHAMBER. Alibekov, M. I.; Eremenko, Yu. A.; Lukin, Yu. T. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 54-7(1972). (In Russian).

Two shower groups were compared which were formed by 200- to 500-GeV cosmic particles with alternate positions of a graphite target, differing by 20 cm from each other. Setting the target inside the Wilson chamber resulted in a particle loss which lay within the limits of statistical error. Placement of the target above the chamber led to a significant loss of particles moving at large angles to the zenith; disregard of these had an effect on multiplicity, angular distribution, coefficient of inelasticity, four-dimensional momenta, etc. (tr-auth)

13073 SEPARATION OF ULTRAHIGH-ENERGY PARTICLES BY THE TRANSITION-RADIATION METHOD. Alikhan'yan, A. I.; Belyakov, E. S.; Garibyan, G. M.; (and others). JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 222-4(20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 315-18(20 Sep 1972).

The results of a study of the transition radiation produced in foamed plastic of density 0.04 g/cm^3 at electron energies of 1 to 4.5 GeV are given. It is shown that the use of the streamer-chamber method with a foamed-plastic emitter enables one to separate protons from pions at energies above 10^3 GeV with 86% efficiency. (J.F.P.)

13074 70-GeV/c PROTONS ELASTICALLY SCATTERED ON AN INTERNAL TARGET. Galyaev, N. A.; Golovnya, N. I.; Grachev, M. I.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1144-51(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1437-45(Jul 1972).

The results of investigations of the formation of a beam of elastically scattered protons using the French "Mirabelle" liquid-hydrogen chamber at the IFVÉ accelerator are given. A description of the beam channel is given and two optical systems for the formation of a proton beam with prescribed parameters are discussed. The channel is tuned by slow (up to 1.5 sec) guidance of the accelerated beam onto the target. The intensity of the protons scattered through an angle of 11.5 mrad within a solid angle of 4 μsr exceeds 10 protons per cycle when the intensity of the 70-GeV proton beam is 10^{12} particles per cycle. When the channel is adjusted the fast system (~0.5 msec) for guidance of the beam onto the target is brought into operation. Operation of this system in conjunction with a deflection magnet mounted in the channel provides the delivery of the required number of particles into the chamber. (auth)

13075 ANTIPROTON–NUCLEUS ANNIHILATION CROSS SECTION VARIATION WITH MASS NUMBER AT 3 GeV/c. Brou, R. (Univ., France). Nuovo Cim.; 13A: No. 1, 257-66(1 Jan 1973). (In French).

The analysis by three different methods of stars created in ionographic emulsion by proton and antiproton beams of 3 GeV/c give an agreement in the estimation of the antiproton annihilations on complex nuclei at about 50%. Experimental annihilation cross sections on hydrogen (26.1 ± 6.8) mb, light nuclei CNO (186 ± 83) mb and heavy nuclei AgBr (681 ± 100) mb are compared with theoretical calculations of the granular nucleus model. (auth)

13076 NEW CHARACTERISTIC IN TWO-PARTICLE CORRELATIONS. Iwai, J.; Okamoto, Y. (Waseda Univ., Tokyo). Lett. Nuovo Cim.; 6: No. 1, 36-8(6 Jan 1973).

An analysis of data on p + p interactions at 24 GeV/c in a bubble chamber was made. The correlation function was constructed, and the rapidity distribution of pions relative to the recoil nucleon was shown. (JFP)

13077 PARALLEL PENETRATING PARTICLES UNDERGROUND. EXPERIMENTAL MULTIPLICITIES AND NUCLEON PRIMARY ENERGIES. Bergamasco, L. (CNR, Turin); Castagnoli, C.; D'Ettorre, B.; (and others). pp 1401-3 of 12 International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol. 4).

The results on the parallel multiple particles traversing contemporarily two spark chambers telescopes situated at a depth

of 40 m.w.e. are reported. The experimental multiplicities of the parallel particles are related to the primary nucleon energies according to the isobar-pionization model modified for the fireball motion. The experimental multiplicity spectrum, involving energies from 10^{16} to 10^{18} eV, is in satisfying agreement with the predictions of the model when the telescope factors are calculated taking account simultaneously of the geometrical and phenomenological features. (auth)

13078 HELICITY NONCONSERVATION IN THE REACTION $dp \rightarrow dp\pi^+\pi^-$ AT 25 GeV/c. Chapman, J. W.; Cooper, J. W.; Roe, B. P.; Sinclair, D.; Vander Velde, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 30: No. 2, 64-7(8 Jan 1973).

The reaction $dp \rightarrow d(p\pi^+\pi^-)$ is observed which allows no exchange of isospin between beam and target particles and therefore may approximate pure diffractive dissociation at this energy. The decay of the $p\pi^+\pi^-$ system is not azimuthally isotropic around its direction in the overall c.m. frame, vitiating its interpretation as a fireball. Both s- and t-channel helicity conservation fail for the process. (auth)

13079 pp INTERACTIONS AT 303 GeV/c: INCLUSIVE MEASUREMENT OF $\Delta^{++}(1236)$ RESONANCE PRODUCTION. Dao, F. T. (Univ. of California, Los Angeles); Gordon, D.; Lach, J.; (and others). Phys. Rev. Lett.; 30: No. 1, 34-7(1 Jan 1973).

Substantial $\Delta^{++}(1236)$ production was observed in the inclusive reaction $p + p \rightarrow \Delta^{++} +$ everything at 303 GeV/c ($\sqrt{s} = 23.9$ GeV). This process with $t_{p,\Delta} < 1.0$ GeV^2 accounts for ~14% of the total pp inelastic cross section. The mean invariant mass of "everything" is ~11 GeV, which implies that the Δ^{++} is usually part of a higher-multiplicity system moving in its hemisphere. The distribution in squared transverse momentum to the Δ^{++} falls off exponentially with a slope of about 12 GeV^{-2}. (auth)

13080 ANGULAR DISTRIBUTIONS OF $\bar{p} + d \rightarrow \pi^- + \pi^+ + (n)$ AT INCIDENT MOMENTA BELOW 400 MeV/c. Krinsky, B. Albany; State Univ. of New York (1972). 104p. University Microfilms Order No. 72-31,781.

Thesis.

The center of mass angular distributions were measured for the reaction $\bar{p}d \rightarrow \pi^+\pi^-(n)$ both at rest and in flight at momenta below 400 MeV/c. The events were obtained from an exposure of 1.8×10^6 annihilations of antiprotons in the 30" BNL deuterium filled bubble chamber. The in flight angular distributions are asymmetric with the π^- tending to follow the direction of the incident $\bar{p}$. Attempts to fit these distributions using only S and P waves fail even in the region of very low momentum (~65 MeV/c c.m.). The at rest distributions are found to be symmetric but nonuniform and are fitted extremely well using S and P waves. It is argued that these results are inconsistent with the S-state capture hypothesis. (Diss. Abstr. Int., B)

13081 DIFFRACTIVE DISSOCIATION OF HADRONS. Lubatti, H. J. (Univ. of Washington, Seattle). Acta Phys. Pol.; B3: No. 6, 721-68(1972).

Diffractive dissociation of pions, kaons and nucleons is reviewed, and the data are compared with elastic scattering. Similarities in the final states are stressed, and the important role of off-mass-shell π-hadron scattering in diffractive dissociation is emphasized. Several new experimental techniques employed in the study of diffractive processes are discussed. (auth)

Strong (Meson-induced)

Refer also to abstract 13438.

13082 (ANL/HEP-7254) MESON RESONANCES. Diebold, R. (Argonne National Lab., Ill.). Nov 1972. 72p. (CONF-720954-10). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

Several narrow resonances were suggested in the 950 MeV region, but need confirmation. The ambiguity in the I = 0, S-wave $\pi\pi$ phase shift above the ρ was resolved in favor of the down solution. The phase changes rapidly near $K\bar{K}$ threshold, and the data are well fit with a pole at 980-371 MeV. Little variation with mass was found in the phase of the A_1 amplitude, suggesting that it is just kinematic enhancement. There could also be a resonance in this region, but even if it should exist, the mass and width are very uncertain. All high statistics A_2 experiments are well fit by a single Breit-Wigner and the old CERN MMS data were reanalyzed and found to be less significant than originally believed. It seems very likely that the A_2 is an ordinary resonance. A clean high statistics sample of $B(1235) \rightarrow \pi_\omega$ was obtained and yields the expected $J^{PC} = 1^{+-}$. Several experiments have found a new resonance, $\rho' \rightarrow \rho^0\pi^+\pi^-$ with M ~ 1.5 and Γ ~ 0.4 GeV. None of the narrow high mass objects reported previously were confirmed in spite of considerable effort. There are still no exotic mesons. (auth)

13083 (CERN-HERA-72-2) COMPILATION OF CROSS SECTIONS I-K^- AND K^+ INDUCED REACTIONS. Bracci, E.; Droulez, J. P.; Flaminio, E.; Hansen, J. D.; Morrison, D. R. O. (European Organization for Nuclear Research, Geneva (Switzerland)). 1972. 196p. Dep. NTIS (U. S. Sales Only).

A compilation of cross sections of reactions produced by negative and positive kaons on targets of protons, neutrons and deuterons, is presented. This is an updated version of CERN/HERA 70-4 and 70-6 and contains 40% more data values than the earlier publications. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values of the rate of decrease of cross section with incident momentum are given. (auth)

13084 (COO-2197-7) PION-NUCLEON INTERACTION AND MESONIC ATOMS. Progress Report, February 1, 1972-January 31, 1973. Rebka, G. A. Jr.; Kunselman, Raymond (Wyoming Univ., Laramie). 1972. Contract AT(11-1)-2197. 8p. Dep. NTIS.

During the year February 1, 1972, to January 31, 1973, research under Task A: pion-nucleon interaction at LAMPF has been a detailed preparation for LAMPF Experiment #99, "Measurement of the Cross Section for $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ with a Magnetic Spectrometer." A double focusing, split pole spectrometer was designed and detailed drawings for the magnets prepared. A set of silicon surface barrier, (dE/dx) transmission detectors was also designed for the focal plane and are now being procured. Other aspects of the instrumentation and procedure were also reviewed. The progress on Task B: mesonic atoms has included data collection and analysis on kaonic and antiprotonic atoms from Argonne and Brookhaven National Laboratories. Planning was conducted on muonic and pionic atom experiments at LAMPF. (auth)

13085 (GWI-PH-1/72) DATA ANALYSIS IN A COUNTER EXPERIMENT AT THE CERN PS, USING A HELIUM RECOIL SPECTROMETER. Ekeloef, Tord (Uppsala Univ. (Sweden). Gustaf Werner Inst.). May 1972. 38p. Dep. NTIS (U. S. Sales Only).

A counter experiment to measure the $\pi^- + {}^4He$ elastic cross section using a helium recoil spectrometer has been carried out and a description is given of the main lines in the data analysis, including the raw data evaluation, the investigation of systematic and statistical errors, the χ^2 fitting of the data and the comparison of the results with theory. (auth)

13086 (JINR-E1-6598) COHERENT PRODUCTION OF PARTICLES FROM EMULSION NUCLEI BETWEEN 17 AND 67 GeV/c. Khoshmukhamedov, R.; Shabratova, G. S.; Tolstov, K. D.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 9p. Dep. NTIS (U. S. Sales Only).

The cross sections of the coherent generation on the photoemulsion nuclei in the reactions: $\pi^-A \rightarrow \pi^+ + \pi^- + \pi^- + A$; $p + A \begin{matrix} p + \pi^+ + \pi^- \\ n + \pi^+ + \pi^- + \pi^- \end{matrix}$ are determined in the energy range of 17 to 67 GeV/c. The results are compared with the calculations performed on the basis of various theoretical models. (auth)

13087 (LBL-1020) STRUCTURE IN THE $2\pi^0$ MASS SPECTRUM IN THE REACTION $\pi^-p \rightarrow n\pi^0\pi^0$ AT 1.6 TO 2.4 GeV/c. Skuja, A.; Wahlig, M. A.; Risser, T. B.; Pripstein, M.; Nelson, J. E.; Linscott, I. R.; Kenney, R. W.; Dahl, O. I.; Chaffee, R. B. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jul 1972. Contract W-7405-eng-48. 28p. (CONF-720954-4). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

A study of the reaction $\pi^-p \rightarrow n\pi^0\pi^0$ between 1.6 and 2.4 GeV/c, in which all the final-state particles were detected using a 3.7 π-steradian array of optical spark chambers and shower counters and a set of 20 neutron counters subtending a polar lab angle region of 12 to 72 degrees are reported. The most prominent feature of the reaction at low four-momentum-transfer, t, to the nucleon, is $\Delta(1236)$ production. The $2\pi^0$ mass spectrum at low t [<0.3 (GeV/c)^2], with $\Delta(1236)$ events removed, exhibits a marked enhancement with respect to peripheral phase space in the region above 700 MeV. The quantum numbers for the observed structure are consistent with T = 0, J = 0. The enhancement was parametrized in two ways: as a Breit-Wigner shape resonance, which gives an acceptable fit to the data with a fitted mass of 820 ± 15 MeV and width of 220 ± 60 MeV, and in terms of the one-pion-exchange model modified by the Dürr-Pilkuhn form factor. The data completely rule out the so-called "down-up" solution. (auth)

13088 (TID-26239) DATA PROCESSING AND PRELIMINARY RESULTS OF π^+D AT 15 GeV/c. Wind, B. B. (Florida State

Univ., Tallahassee. High Energy Physics). Aug 1972. Contract AT(40-1)-3509. 60p. Dep. NTIS.

There were 74,000 exposures from 350,000 exposures of the SLAC 82" bubble chamber measured on the University of Pennsylvania Hough-Powell Device and processed in a first pass, which is described. There were 1288 constrained 4-prong, 6-prong, and 8-prong coherent and charge exchange events identified. The ρ, d*, and A_1 resonances are seen, and meson masses as large as 4.5 GeV occur. (auth)

13089 (UCLA-10-P-25-6 Rev) MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR $\pi^-p \rightarrow \pi^0 n$ BETWEEN 502 AND 888 MeV/c. Blasberg, D. J.; Comiso, J. C. (California Univ., Los Angeles); Crowe, K. M.; (and others) (California Univ., Berkeley. Lawrence Radiation Lab.). [nd]. 25p. (CONF-720954-9). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

Forty-two differential cross sections of the pion-nucleon charge exchange reaction were measured at total center-of-mass energies between 1371 and 1609 MeV. A neutron time-of-flight technique is used to identify charge-exchange events. These measurements will improve the phase shift analyses in this region and provide better parameters for the $P_{11}(1470)$ resonance. The results are consistent with the Ayed-Bareyre-Sonderegger phase degeneracy hypothesis at $\tilde{\theta}_{\pi^0} = 180°$. (auth)

13090 (UCLA-10-X-1) PARTICLE PHYSICS. Technical Progress Report. Haddock, R. P. (California Univ., Los Angeles). 1972. Contract AT(11-1)-Gen-10. 12p. Dep. NTIS.

A summary of experimental research on strong interactions is presented. A list of publications is included. (JFP)

13091 (UCR-34-P-10-7-B-140) ANNUAL REPORT. Kernan, A.; Poe, R. T. (California Univ., Riverside). May 1972. Contract AT(04-3)-34. 25p. Dep. NTIS.

Experimental research on strong interactions is summarized. A list of publications is included. (JFP)

13092 (UH-511-124-72) HEURISTIC MODEL FOR MULTIPARTICLE PRODUCTION IN π-p INTERACTIONS. Johnson, A. D. (Hawaii Univ., Honolulu. Dept. of Physics and Astronomy). 1972. Contract AT(04-3)-511. 162p. Dep. NTIS.

Thesis.

Models based upon pion-exchange and diffraction dissociation were fitted to data from reactions of the type $\pi^-p \rightarrow$ Nucleon + $k\pi$, $2 < k < 7$ at 3.9 and 11.9 GeV/c incident momentum. These models, which include resonance production, give approximately correct mass- and t-distributions, as well as transverse and longitudinal components of momentum. Partial cross sections for dominant channels were estimated, and relations between cross sections compared with theoretical predictions. (auth)

13093 PROPERTIES OF THE ϕ AND f' PRODUCED IN THE CHANNEL $K^+p \rightarrow K^+pK\bar{K}$ AT 10 GeV/c. Cooley, D. C. (Univ.. of Birmingham, Eng.); Jobes, M.; Riddiford, L.; (and others). Nucl. Phys.; B50: No. 1, 1-9(1972).

Data are presented, and cross sections given for ϕ and f' production in the channel $K^+p \rightarrow K^+pK\bar{K}$ at 10 GeV/c. The resonance parameters obtained from a fit to the $K\bar{K}$ effective mass distribution are $M = (1020.4 \pm 0.5)$ MeV/c and $\Gamma = (5.0 \pm 1.3)$ MeV/c^2 for the ϕ meson and $M = (1514 \pm 4)$ MeV/c^2 and $\Gamma = (28 \pm 15)$ MeV/c^2 for the f'. The resonance widths are corrected for experimental resolution. The branching fraction for the rate $(\phi \rightarrow K_1^0K_2^0)/(\phi \rightarrow K^+K^-)$ is determined to be 1.15 ± 0.15. The angular distributions for the decay of the f' have unnormalized moments H(2,0) and H(4,0) different from the values for the nearby background, indicating spin 2 or greater for the f'. (auth)

13094 ρ-POLARIZATION IN THE REACTION $\pi^-p \rightarrow \pi^+\pi^-n$ AT 17 GeV. Grayer, G. (CERN, Geneva); Hyams, B.; Jones, C.; (and others). Nucl. Phys.; B50: No. 1, 29-43(1972).

The data from a spark chamber experiment are analyzed for dipion masses below 1 GeV in terms of the s- and p-wave density matrix. The measured elements are given as functions of the dipion mass and of the momentum transfer. Bounds for the unmeasured matrix elements ρ_{11}, $\mathrm{Im}\rho_{10}$, $\mathrm{Im}\rho_{0s}$, $\mathrm{Im}\rho_{1s}$ are calculated using the positivity constraint. The intervals are very small and suggest that the production process has the property of equal phases of the amplitudes referring to the same $\pi\pi$ angular momentum. Next, the eigenvalues of the density matrix are determined within the positivity domain, showing that the rank is never greater than 3, and equal to 2 at the peak of the ρ meson, but could also be generally 2. (auth)

13095 LONGITUDINAL PHASE SPACE ANALYSIS OF SIX-BODY EVENTS. Aachen-Berlin-Bonn-CERN-Cracow-Dubna-Durham-Heidelberg-Nijmegen-Paris (E.P.)-Saclay-Torino-Warsaw Collaboration. Nucl. Phys.; B50: No. 1, 61-79(1972).

The reaction $\pi p \rightarrow p5\pi$ was studied in six-prong events of π^+p interactions at 5, 8 and 16 GeV/c and of π^-p interactions at 5, 11 and 16 GeV/c, using the longitudinal phase space (LPS) technique. The energy dependence of cross sections in LPS sectors was found to depend on the charge and the baryon number "exchanged" between the primary pion and the group of forward-going secondary particles. Selection of certain LPS sectors greatly improves the separation of resonances from background. A strong correlation was observed between fast forward beam-like pions and protons slow in the cms. A simple interpretation of this observation is discussed. (auth)

13096 COHERENT PRODUCTION OF $K^{*+}(890)$ ON NUCLEI AND DETERMINATION OF AN UPPER LIMIT FOR THE RADIATIVE DECAY WIDTH GAMMA ($K^{*+} \rightarrow K^+\gamma$). Bemporad, C. (CERN, Geneva); Beusch, W.; Dufey, J. P.; (and others). Nucl. Phys.; B51: 1-15(1973).

The coherent production of $K^{*+}(890)$ on nuclei ranging from C to Pb at 10, 13, and 16 GeV/c were observed. Fitting a model of coherent production, including strong and electromagnetic interactions and their interference, to the measured coherent production cross section the strong contribution is found to be dominant and the upper limit of the radiative decay width $\Gamma(K^{*+} \rightarrow K^+\gamma) <$ 80 keV was determined with 95% confidence. (auth)

13097 REACTION $\pi^+p \rightarrow \omega\Delta^{++}(1236)$ AT 11.7 GeV/c. Evans, D. (Univ. of Durham, Eng.); Maddock, R. O.; Pinter, G. F.; (and others). Nucl. Phys.; B51: 205-20(1973).

For the reaction $\pi^+p \rightarrow \omega\Delta^{++}$ data on the total cross section ($\sigma = 61 \pm 12$ μb), differential cross sections, spin density matrix elements and statistical tensor elements are given. Natural and unnatural parity exchange contributions to the total cross section are observed. It is noted that the value of ρ_{00} is not zero and in the helicity frame exhibits a dip at $t \approx -0.25$ (GeV/c)^2. A qualitative theoretical discussion of the results is presented. (auth)

13098 RESONANCE PRODUCTION IN FIVE-BODY FINAL STATES FROM K^+p INTERACTIONS AT 5 GeV/c. Charriere, G. (CERN, Geneva); Drijard, D.; Goldschmidt-Clermont, Y.; (and others). Nucl. Phys.; B51: 317-52(1973).

The final states corresponding to the reaction $K^+p \rightarrow KN\pi\pi\pi$ are studied at 5.0 GeV/c incident momentum. The general characteristics of these reactions are given. A more detailed study is made of resonance production. The more abundantly produced resonances are K*(892), Δ(1236), ρ, ω, η, K*(1420), N*(1520), and N*(1700). Fits to the multidimensional space of effective masses show that for the final state $K^0p\pi^+\pi^-\bar{\pi}^-$, more than 30% of the reaction proceeds through quasi two-body intermediate states, and that more than 88% proceeds through the production of at least one resonance. Some evidence is found for the production of other resonances such as $K^*(1660) \rightarrow K3\pi$, $\Delta(1920) \rightarrow p\pi^+\pi^+\pi^-$ and $N^*(2064) \rightarrow p\pi^+\pi^-\pi^0$. Several examples of cascade decays are found, but no direct decay into more than three bodies is observed. (auth)

13099 LAMBDA PRODUCTION IN Kp COLLISIONS AT 13 GeV/c. Barletta, W. (Yale Univ., New Haven); Johnson, M.; Ludlam, T.; (and others). Nucl. Phys.; B51: 499-508(1973).

The inclusive reactions $K^-p \rightarrow \Lambda$ + anything, $K^+p \rightarrow \Lambda$ + anything and $K^+p \rightarrow \Lambda$ + anything at 13 GeV/c are compared. It is found that the first of these reactions includes significant contributions ($\gtrsim$30%) from processes other than the annihilation reaction $K^-p \rightarrow \Lambda$ + pions, and that this non-annihilation component contributes backward (target-like) and forward (beam-like) Λ's whole dynamical origins may be related to those of backward Λ's and forward Λ's produced in K^+p collisions. It is suggested that diffractive processes are playing an important role in these reactions. (auth)

13100 REACTIONS $K^-p \rightarrow 0^-\frac{1}{2}^+$ AT AN INCOMING MOMENTUM OF 4.25 GeV/c. Blokzijl, R. (Univ., Amsterdam); de Groot, A. J.; Hoogland, W.; (and others). Nucl. Phys.; B51: 535-51(1973).

A bubble-chamber study is presented of a 10 events/μb experiment using K^- mesons of 4.25 GeV/c incident momentum. Differential and total cross sections are determined for 7 different reactions: $K^-p \rightarrow \bar{K}^0n$(1a), $\rightarrow \pi^0\Lambda$(1b), $\rightarrow \eta\Lambda$(1c), $\rightarrow \eta'\Lambda$(1d), $\rightarrow \pi^-\Sigma$(1e), $\rightarrow \pi^+\Sigma^-$(1f), $K^+\Xi^-$(1g). The experimental characteristics in $d\sigma/dt$ of each reaction are described: (1a) shows a levelling off at $t = 0$ (GeV/c)^2, a break at $t = -0.6$ (GeV/c)^2 and no backward events, (1b) $d\sigma/dt$ has a smooth behavior and a measurable backward component with an indication of a dip at $u = -0.2$ (GeV/c)^2, (1c) $d\sigma/dt$ shows a dip in the region between $t \approx -0.2$ and -0.4 (GeV/c)^2, (1d) $d\sigma/dt$ has a smooth behavior; neither this reaction nor the preceding one shows a clear evidence for backward events, (1e) $d\sigma/dt$ has a break at $t = -0.5$ (GeV/c)^2; there is a significant cross section in the backward region: (1f) and (1g)

show mainly backward production. The polarization of the hyperon is measured in the reactions (1b), (1c), (1d), and (1e) in the forward production peak. The statistics do not allow the detection of a definite structure in the polarization but the sign and magnitude are determined. An interpretation of the results is given in terms of a dual Regge model, including the effects of absorption as elaborated recently by several authors. (auth)

13101 PROBABILITY OF ABSORPTION OF K^--MESONS AT REST ON FREE PROTONS IN PROPANE. Vander Velde-Wilquet, C. (Univ. Libre, Brussels); Keyes, G. S.; Sacton, J.; (and others). Lett. Nuovo Cim.; 5: No. 17, 1099-1103(23 Dec 1972).

The absorption of K^- mesons at rest in carbon nuclei was studied in a heavy-liquid bubble chamber experiment. A total of 1596 events of the type $K^- + p \rightarrow \Sigma^- + \pi^+$ was detected in the sample. The probability of K^- capture on free protons in a mixture of hydrocarbons was estimated to be 0.040 ± 0.004. (L.B.S.)

13102 PRODUCTION OF HIGH MASS BOSONS AND THEIR BRANCHING DECAYS. Tebes, J. Jr. Lafayette, IN; Purdue Univ. (1972). 293p. University Microfilms Order No. 72-30,990.

Thesis.

This report concerns itself with the study of multipion and strange particle final states produced by the interaction of 13.1 GeV/c π^+ mesons on hydrogen and deuterium. The data were obtained from three separate exposures at the 82'' Bubble chamber at the Stanford Linear Accelerator. A significant confirmation of narrow high mass bosons is provided in the charged and neutral two and four pion final states. The di-pion mass structure at a mass of 1.65 GeV/c^2 (g-meson) and 2.2 GeV/c^2 (T-meson) is shown to have quantum numbers $I^G = 1^+$ and $J^P = 3^-$ and $J^P = 5^-$ respectively. These di-pion decay modes are produced via OPE (one-pion-exchange) and appear to lie on the ρ Regge-trajectory. The combined structure in the R-region was found to correspond remarkably well in mass and cross section to the CERN Missing Mass Spectrometer data. At the same time there is a notable absence of any enhancements in the U-region in the data. Narrowing of resonance width as a function of increasing boson mass is not found in the data. The mass difference between the 3^- and 2^- state in the R-cluster is less than 10 MeV/c^2. So spin-orbit forces are rather small in the R-region and would not lift the degeneracy of the R-cluster as predicted on the basis of the quark model. (Diss. Abstr. Int., B)

13103 DISCOVERY OF A MESON DECAYING INTO $\omega + \pi^+$ IN π^+p INTERACTION AT 3.5 GeV/c. Yager, P. M. San Diego, CA; Univ. of California (1972). 54p. University Microfilms Order No. 72-28,513.

Thesis.

This study of π^+p interactions at 3.5 GeV/c concentrates on the production of multiparticle resonance states. The experimental methods and data reduction procedures are described. Evidence and cross-section measurements are presented for the reactions $\pi^+p \rightarrow \pi^+p\pi^+\pi^-$, $\pi^+p \rightarrow \pi^+p\pi^+\pi^-\pi^0$, and $\pi^+p \rightarrow \pi^+n\pi^+\pi^+\pi^-$. A systematic search for multiparticle resonant states in the $\pi^+p \rightarrow \pi^+p\pi^-\pi^-\pi^0$ reaction indicates strong ω production via $\pi^+p \rightarrow \pi^+p\omega$, $\omega \rightarrow \pi^+ + \pi^- + \pi^0$. Further investigation reveals that the π^+ and ω above are often the decay products of a previously unknown mesonic state called the B meson. The mass and width of this state are found to be 1.22 GeV/c and 0.10 ± 0.02 respectively. The broad width and decay products indicate an isotopic spin assignment of 1. An attempt to measure the spin and parity of the B is made. The confirmatory evidence of subsequent experimenters is discussed. (Diss. Abstr. Int., B)

13104 EVIDENCE FOR THE EXISTENCE OF TWO $\Sigma(1660)$ RESONANCES. Apsell, S. P. Waltham, MA; Brandeis Univ. (1972). 163p. University Microfilms Order No. 72-32,084.

Thesis.

A study was made of the reaction 1) $K^- + p \rightarrow \Sigma^+(1660) + \pi^-$. A one-million picture exposure of the Brookhaven National Laboratory 31 inch hydrogen bubble chamber, using an incident beam of 2.95 GeV/c K^- mesons, provided data on $\Sigma^+(1660)$ resonance production in the following final state interactions: 2) $K^- + p \rightarrow \Sigma^\pm + \pi^\mp + \pi^+\pi^-$ and 3) $K^- + p \rightarrow \Sigma^+ + \pi^0 + \pi^-$. This experiment had a sensitivity of 13.5 events/μb for reaction 2) and 10.2 events/μb for reaction 3). This investigation of reaction 1) showed the existence of resonance production in the 1660 MeV/c^2 mass region. The mass and width of this resonance were experimentally measured yielding values of 1651 ± 7 MeV/c^2 and 58 ± 3 MeV/c^2 respectively, and the principal decay mode was determined to be $\Sigma^+(1660) \rightarrow \Lambda^0(1405) + \pi^+$. In addition, the cross section for $\Sigma^+(1660)$ production was measured as a function of production angle and this data was used to investigate a possible production mechanism for reaction 1). The investigation of reaction 3) produced no evidence for the existence of a $\Sigma\pi$ decay mode of the $\Sigma(1660)$. A measurement was made of the $\Sigma(1660)$ spin-parity using three independent methods. The first, an Adair analysis, indicated spin $\frac{3}{2}$. However, evidence was produced that this method may be invalid when applied to the $\Sigma(1660)$. The objections to the Adair analysis were overcome by a Byers-Fenster analysis of the data. Unfortunately, the $\Sigma(1660)$ decay sequence proved to be a particularly difficult one to analyze by this method and the only conclusion drawn was that the spin of the $\Sigma(1660)$ is $\frac{3}{2}$ or greater. The final approach was to assume the vector meson exchange model of Stodolsky and Sakurai to be an accurate description of the $\Sigma(1660)$ production process. The predictions of this model for the $J^P = \frac{3}{2}^-$ state were in excellent agreement with the experimental data. (Diss. Abstr. Int., B)

13105 INVESTIGATION OF THE REACTION $K^-p \rightarrow K^-\pi^+n$ AT $p_{lab} = 2$ GeV/c. Chu, D. Pasadena, CA; California Inst. of Tech. (1972). 237p. University Microfilms Order No. 72-30,795.

Thesis.

The reaction $K^-p \rightarrow K^-\pi^+n$ was studied for incident kaon momenta of 2.0 GeV/c. A sample of 19,881 events was obtained by a measurement of film taken as part of the K-63 experiment in the Berkeley 72 inch bubble chamber. Based upon the analysis, four conclusions were reached. (1) The magnitude of the extrapolated $K\pi$ cross section differs by a factor of 2 from the P-wave unitarity prediction and the K^+n results; this is probably due to absorptive effects. (2) Fits to the moments yield precise values for the $K\pi$ S-wave which agree with other recent statistically accurate experiments. (3) An anomalous peak is present in the backward $K^-p \rightarrow (\pi^+n)\ K^-$ u-distribution. (4) A non-linear enhancement due to interference similar to the one found by Blane et al., (Bland 1966) is found. (Diss. Abstr. Int., B)

13106 STUDY OF FINAL STATES OBSERVED IN THE THREE AND FOUR PRONG TOPOLOGIES IN K^-d INTERACTIONS AT 3.4 GeV/c. Nicholas, M. L. Lawrence, KS; Univ. of Kansas (1972). 118p. University Microfilms Order No. 72-32,913.

Thesis.

From an approximately 100,000 frame exposure of the Argonne National Laboratory deuterium bubble chamber to a 3.4 GeV/c negative kaon beam, an analysis is presented of neutron target and coherent deuteron reactions for the three and four prong topologies. Reaction cross sections are compared to data at neighboring energies and found to be consistent with a gradual decrease in cross section as a function of beam momentum, while the cross section for the coherent reaction increases. The final state $K^-\pi^+\pi^-d$ is found to be dominated by $K^{*0}(890)$ production. The $K^-\pi^+\pi^-$ effective mass distribution exhibits a broad structureless enhancement from 1100 to 1500 MeV. The final state $K^-\pi^+\pi^-np_s$ forms the double resonances $K^{*0}(890)$ $\Delta^-(1238)$ approximately 60% of the time. The data are compared with an OPE model with off-mass shell corrections. The decay density matrix elements of the resonances are presented in both the Gottfried-Jackson and Helicity frames. The final state $K^-p\pi^-p$ is found to have moderate $Y^*(1520)$ and $Y^*(1815)$ production together with multiperipheral effects. The data are compared with a double-Regge model which gives an adequate description of the data at higher energies. (Diss. Abstr. Int., B)

13107 LONGITUDINAL CONFIGURATIONS OF THREE- AND FOUR-BODY REACTIONS CONTAINING STRANGE PARTICLES PRODUCED IN π^-p COLLISIONS AT 11.2 GeV/c. Tomasini, G. (Univ., Genoa); Trevisan, U.; Borzatta, P.; (and others). Nuovo Cim.; 12A: No. 4, 1087-1105(21 Dec 1972).

The reactions $\pi^-p \rightarrow \pi KY$, KKN, $\pi\pi KY$, πKKN at 11.2 GeV/c are analyzed using longitudinal phase space (LPS) plots with some 800 events. In spite of the very limited statistics often available the LPS analysis proves to be useful in understanding the processes responsible for both strange-particle and resonance production. Quasi-two-body processes are the main characteristics of three-particle final states, while the dominant mechanism in four-body reactions is the dissociation of the incident pion also in the case where strangeness exchange is necessary. (auth)

13108 EXPERIMENTAL RESULTS OF 60GeV/c π^+-NUCLEON INELASTIC COLLISIONS COMPARED WITH SOME RECENT MODELS. Agnese, A. G. (Univ., Genoa); Wataghin, A.; Shabratova, G. S.; Tolstov, K. D. Nuovo Cim.; 13A: No. 1, 144-52 (1 Jan 1973).

The experimental results of 60-GeV/c π^--nucleon inelastic collisions are compared with the fireball and model and with limiting-fragmentation predictions. While the agreement with limiting-fragmentation predictions is not good (at this energy), the comparison with the one-fireball model is good in 15% of the

events studied. The measured inelasticity is near to the maximum inelasticity predicted by the quark model. The mass of the fireballs is (2.61 ± 0.37) GeV and the average momentum of the emitted pions in the fireball reference system is (213 ± 59) MeV/c. (auth)

13109 STUDY OF PION PRODUCTION IN COLLISIONS OF PROTONS AND K^+ MESONS WITH INCIDENT IMPULSES OF 5 AND 8.2 GeV/c. de Wolf, E. Ghent; Ghent Rijksuniversiteit (1971). 125p. (In Dutch).

Thesis.

The interactions K^+p at 5 and 8.2 GeV/c as well as the reaction $K^+ + p \rightarrow K^+ + p + 2\pi^+ + 2\pi^-$ are studied. The general characteristics of the inelastic reactions are described, and particular attention is given to resonance production and to the analogy with reactions with two quasi-particles. The existence of dynamical angular correlations between pions is shown. (tr-auth)

13110 DIFFRACTION COHERENT GENERATION OF PARTICLES BY THE INTERACTION OF 45-GeV PIONS WITH EMULSION NUCLEI. Azimov, S. A.; Basova, E. S.; Gulyamov, U. G.; (and others) (Inst of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 5, 14-18(1971). (In Russian).

Reactions were investigated which lead to the coherent production of pions: $\pi^-A \rightarrow A\pi^-\pi^-\pi^+$, $\pi^-A \rightarrow A\pi^-\pi^-\pi^+\pi^0\pi^0$, and $\pi^-A \rightarrow A\pi^-\pi^-\pi^-\pi^+\pi^+$, as a result of collisions of 45 GeV π^--mesons with nuclei in photoemulsion. The overall length of the primary trace was 2,725 m, whereas the average range for an inelastic event was 40 cm. The distribution of track lengths relative to the number of particles produced was studied. (KSW)

13111 $K\pi$ AND $K\pi\pi$ SPECTRUM FROM K^+ MESON CHARGE EXCHANGE INTERACTIONS IN DEUTERIUM AT 9 GeV/c. Clopp, H. W. Jr. Lafayette, IN; Purdue Univ. (1972). 123p. University Microfilms Order No. 72-30,874.

Thesis.

The results of a study of the $K\pi$ and $K\pi\pi$ spectrum produced by a 9-GeV/c K^+ meson beam targeted on a deuterium filled bubble chamber are presented. The reaction $K^+n \rightarrow K^+\pi^-p$ is found to be dominated by K*(890) and K*(1420) production. In addition, evidence is presented for an $I = \frac{1}{2}$, $J^P = 3^-$ resonance at $M(K\pi) = 1753$ MeV. The reaction $K^+n \rightarrow K\pi\pi p$ is dominated by K*(1420) and $K_N(1760)$ production. In addition, a five standard deviation signal is observed at 2150 MeV. Branching ratios are presented for the K*(1420) and $K_N(1760)$. (Diss. Abstr. Int., B)

13112 STUDY OF NEUTRAL FINAL STATES IN K^-P INTERACTIONS AT THE CENTER OF MASS ENERGIES FROM 1580 TO 1720 MeV. Dombeck, T. W. Evanston, IL; Northwestern Univ. (1972). 342p. University Microfilms Order No. 72-32,422.

Thesis.

The results presented in this thesis are from a K^-p formation experiment performed in the Argonne-Michigan 40" heavy liquid bubble chamber. There were 500,000 pictures in the exposure taken in the chamber mixture of 80% propane (C_3H_8) and 20% freon (CF_3Br). The final states that formed the primary investigation in this experiment were $\Sigma^0\pi^0$, $\Lambda\pi^0\pi^0$ and $\Sigma^0\pi^0\pi^0$ in the center of mass energy range near 1670 MeV. The heavy liquid techniques employed in this experiment are discussed in detail. These include corrections made for scanning losses of gamma rays and an estimate of the background originating from interactions off heavy nuclei in the liquid. Also, a correction was devised for the background originating from multi-gamma ray events which fed into lower constraint final states because not all of their gamma rays were detected. The ensuing analysis of the $K\pi_2$ decays as well as the $\Lambda\pi^0$, $\Lambda\eta^0$, $\Lambda\pi^+\pi^-$ and $\Sigma^0\pi^+\pi^-$ final states was compared with previous data from hydrogen experiments. This showed the consistency of the techniques and proved that a relatively pure sample of hydrogen events had been isolated. Cross sections for all the final states investigated in this momentum region are reported. The absolute normalization was performed using the observed tau decays to determine the kaon flux in this experiment. The angular distributions for $\Lambda\pi^0$ and $\Sigma^0\pi^0$ are also presented and compared with previous measurements in hydrogen bubble chambers. Because hydrogen chambers cannot detect gamma rays, the technique that had been used previously to obtain the $\Sigma^0\pi^0$ angular distributions was checked. Some differences were observed in the data that might be attributed to a contamination in the hydrogen data from the multiple π^0 final states. The Dalitz plots were investigated for charged and neutral three body final states. The data were consistent with the $\Lambda\pi^+\pi^-$ and $\Lambda\pi^0\pi^0$ final states being produced entirely through $\Sigma(1385)\pi$. The $\Sigma^0\pi^0\pi^0$ data were consistent with almost total $\Lambda(1405)\pi$ production. (Diss. Abstr. Int., B.)

13113 $K_L^0p \rightarrow pK_S^0$ BACKWARD SCATTERING FROM 1.0 TO 7.5 GeV/c. Brandenburg, G. W.; Johnson, W. B.; Leith, D. W. G. S. (and others) (Stanford Univ., CA). Phys. Rev. Lett.; 30: No. 4, 145-8(22 Jan 1973).

Backward scattering in the reaction $K_L^0p \rightarrow pK_S^0$ is studied in the momentum interval 1.0 to 7.5 GeV/c. Comparison of $K_L^0p \rightarrow pK_S^0$ and $K^+p \rightarrow pK^+$ backward scattering, where respectively Σ exchange and Λ plus Σ exchange can contribute in the u channel, reveals that $(d\sigma/d\Omega)_{180°}(K_L^0p \rightarrow pK_S^0) \ll (d\sigma/d\Omega)_{180°}(K^+p \rightarrow pK^+)$ above the resonance region. This result provides direct evidence for the dominance of the Λ contribution over the Σ contribution in the $K^+p \rightarrow pK^+$ production amplitude. (auth)

13114 COHERENT PRODUCTION OF NUCLEI BY π AND K MESONS (EXPERIMENT). Beusch, W. (CERN, Geneva). Acta Phys. Pol.; B3: No. 6, 679-719(1972).

In these lectures some experimental methods useful for detecting coherent processes are compared. Experimental results of coherent production by π and K mesons are discussed. High statistics results were obtained from a counter experiment performed at CERN. The optical model for multiple scattering is shown to fit the data of 3π, 5π, and $K\pi\pi$ production very well, while some doubts as to its application to K*(890) production remain. The main results of the analysis are the following. The absorption of 3π and 5π systems in nuclear matter is small; it corresponds to a total cross section $\sigma \approx 25$ mb. Mass distributions of 3π, 5π and $K\pi\pi$ show broad structureless peaks. Both 3π and $K\pi\pi$ are almost 100% two-body systems with $\pi\rho$ and πf for 3π and $K^*(890)\pi$ in $K\pi\pi$ (no $K\rho$ observed). The 3π Dalitz plot distributions show structure within the $J^P = 1^+$ amplitude, possibly S–D interference of the $\pi-\rho$ state. The production cross section of 3π on a nucleon, deduced from a fit over nine target elements, seems to rise by 30% from 9 to 15 GeV, while the absorption in nuclear matter appears unchanged. Coherent production of K*(890), a nondiffractive process, is clearly observed. A model for this process including Coulomb production, strong production, and their interference, is discussed. A fit to 10 data points, the integrated coherent production cross sections on five elements and three beam momenta, gives $0 < \Gamma(K^* \rightarrow K\gamma) < 80$ keV. (auth)

13115 PRESENT EXPERIMENTAL STATUS OF HELICITY CONSERVATION IN DIFFRACTIVE PROCESSES. Otter, G. (Institut fuer Hochenergiephysik, Vienna). Acta Phys. Pol.; B3: No. 6, 809-44(1972).

The experimental situation concerning helicity conservation in diffractive processes is reviewed. As an introduction a short repetition of the necessary formulas of the helicity formalism is carried out. The tests for helicity conservation are then derived and the corresponding experimental data are discussed. The results are the following: s-channel helicity conservation seems to hold for elastic diffraction scattering (I include here the photoproduction of the ρ-meson), but nearly all inelastic diffractive processes show small deviations from t-channel helicity conservation. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 13307.

13116 (JINR-E2-6763) ESSENTIAL SELFADJOINTNESS OF DIFFERENT ALGEBRAS OF FIELD OPERATORS. Lassner, G.; Timmermann, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 8p. Dep. NTIS (U. S. Sales Only).

It is proved that any O_p^*-algebra generated by a Wick polynomial of the free field and the number operator is essentially selfadjoint. (auth)

13117 BOOTSTRAPS AND PARTONS. A FIELD GUIDE TO COMPOSITE HADRONS. Harte, John (CERN, Geneva). Nucl. Phys.; B50: No. 1, 301-17(1972).

In a bootstrap theory of infinitely composite hadrons, it is shown that parton-like behavior for inclusive reactions arises naturally. The question is raised: might the bootstrap be equivalent to theories with explicitly local entities, such as partons or currents, playing a fundamental role? It is suggested that the answer is no, and several crucial experiments are pointed out which will distinguish between the bootstrap and theories of composite hadrons with elementary constituents. (auth)

13118 REGGEION CUT DISCONTINUITIES FROM UNITARITY. I. THE REGGEON–PARTICLE CUT. White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B50: No. 1, 93-129(1972).

S-matrix normal threshold discontinuity formulas continued to complex angular momentum and helicity are used to derive the discontinuity across the reggeon-particle cut in the four,

five and six-particle amplitudes. This leads to coupled discontinuity formulas for the four-particle, the three particle/reggeon, and two particle/two reggeon amplitudes in terms of fixed-pole residues of these amplitudes. It is then shown that the "unitarized" cut is a square root branch point. Signature factors are included so that the signature of the cut is derived, and the cut discontinuity is shown to vanish at right signature points. Finally it is shown that the occurrence of the Gribov-Pomeranchuk pole in the cut discontinuity leads to consistency with two-particle unitarity. (auth)

13119 REGGEON CUT DISCONTINUITIES FROM UNITARITY. II. THE TWO-REGGEON CUT. White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B50: No. 1, 130-56(1972).

S-matrix normal threshold discontinuity formulas continued to complex angular momentum and helicity are used to derive the discontinuity across the two-reggeon cut of the four-particle, two-particle/two-reggeon and four-reggeon amplitudes in terms of fixed-pole residues of these amplitudes. The signature of the cut is derived and it is shown to be an inverse logarithmic branch-point. The cut is also shown to "switch-off" the reggeon-particle cut as expected. The two-pomeron cut is shown to contribute negatively to the total cross section. The theoretical and phenomenological uses of the discontinuity formulas are discussed, particularly in relation to the construction of dual amplitudes with cuts and to the derivation of selection rules for cuts based on duality and internal symmetries. (auth)

13120 INCLUSIVE REACTIONS IN THE PIONIZATION LIMIT. Botke, J. C. (Cambridge Univ., Eng.). Nucl. Phys.; B51: 586-610(1973).

The inclusive differential cross section (IDCS) in the pionization limit is discussed via Gribov-Feynman graphs and Mueller's generalized optical theorem. Considering first the infinite energy limit in which the Gribov-Feynman graphs degenerate to reggeon graphs, the usual results for the leading and non-leading behavior are obtained. It is recognized, however, that a number of ambiguities pertaining to energy scales, signs, and relative magnitudes of leading and non-leading contributions are unresolved in this naive theory. It is not possible, for instance to predict whether the approach to a scaling limit, if it exists, will be from below or above. In the second half of the paper, a more detailed discussion is presented with the emphasis on the finite energy behavior. Several of the earlier ambiguities are resolved and some understanding of the ISR data is achieved. Two conclusions reached are that the data exhibits threshold rather than limiting behavior and that the relevant energy scale is $(\eta S)^{\frac{1}{4}}$ rather than $(\eta S)^{\frac{1}{2}}$ as suggested by the more naive theory based on reggeon graphs. (auth)

13121 PARTICLES AND NUCLEI. VOLUME 1, PART 1. Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corporation (1972). 193p.

Translation of Problemy Fiziki Elementarnykh Chastits i Atomnogo Yadra.

Separate abstracts were prepared for each of the seven chapters. (J.F.P.)

For abstracts of individual chapters see: 13028, 13070, 13172, 13192, 13261, 13287, and 13300.

13122 n-PARTICLE INCLUSIVE DISTRIBUTIONS IN THE DUAL-RESONANCE MODEL. Buras, A. J. (Univ. of Copenhagen). Nuovo Cim.; 12A: No. 4, 863-88(21 Dec 1972).

Following Mueller's hypothesis the general formulas for n-particle inclusive distribution functions was found in the framework of the dual-resonance model (DRM) in various kinematic regions. With the help of the cluster decomposition of the DRM amplitudes derived by Chan et al., it was possible to obtain the results in a very compact form. The model predicts a cut-off in transverse momenta of detected particles and short-range correlations. (auth)

13123 LONGITUDINAL PHASE SPACE PLOTS IN ARBITRARY FRAMES. Kajantie, K.; Tuominiemi, J. (Univ. of Helsinki). Phys. Scr.; 5: No. 4-5, 155-8(1972).

Longitudinal phase space plots in arbitrary frames are considered. In any frame moving with constant velocity relative to the target or beam system, these plots, when scaled by the incident momentum, approach regular hypertetrahedrons when s increases. Plots in target and beam system longitudinal momenta are useful for investigating beam and target fragmentation, respectively. (auth)

13124 DUAL MODEL FOR FERMIONS WITHOUT PARITY DEGENERACY ON THE PRINCIPAL TRAJECTORY. Kudryavtsev, V. A.; Levin, E. M. (Leningrad Inst. of Nuclear Physics). Zh. Eksp. Teor. Fiz.; 63: No. 6, 1978-92(Dec 1972). (In Russian).

A dual amplitude for interaction between N − 2 mesons and two fermions in a dual configuration is set up in such a way that parity degeneracy is absent on the principal fermion trajectory. The structure of the j-plane (Regge poles, fixed poles and cuts) is analyzed within the framework of the model. The degree of degeneracy of states with a given mass is calculated. (auth)

13125 INFINITE-COMPONENT PARTICLE EQUATION WITH A WIDELY SPACED MASS SPECTRUM. Wessel, W. (Univ., Heidelberg). Nuovo Cim.; 13A: No. 1, 248-56(1 Jan 1973).

Infinite-component wave equations have been studied previously for the generation of mass eigenvalues, that might explain the masses of the elementary particles. So far no spectra have been found with any resemblance to the existing masses, the intervals rising far too slowly or even descending. A wave equation based on a unitary representation of the Lorentz transformation with nonvanishing Casimir operators (I and K), one of which (K) is continuous, is employed. With its help mass operators are easily formulated and analyzed. A particularly simple one constructed earlier is evaluated in an attempt to quantize the motion of electrically charged particles under the influence of their own field. There results a well defined discrete and increasing, but too widely spaced mass spectrum. The largeness of the intervals is caused by the smallness of the electromagnetic coupling constant ($e^2/\hbar c$) that enters by its reciprocal value. Hence a field with a larger coupling effect, perhaps Heisenberg's matter field, should modify the distribution in the right sense. (auth)

13126 LIGHT-CONE STRUCTURE OF INFINITE-COMPONENT FIELDS. Bebie, H.; Gorge, V.; Leutwyler, H. (Univ., Bern). Ann. Phys. (N. Y.); 74: No. 2, 524-54(Dec 1972).

It is shown that infinite-component models provide examples of nontrivial Bjorken scaling. The scaling functions are evaluated for three different models, and it is shown that the result agrees with the structure of the leading light-cone singularity. (3 figures) (auth)

13127 BEHAVIOR OF SCALAR AND SPIN ½ PARTICLES IN THE FIELD OF TWO INTENSE ELECTROMAGNETIC WAVES. Berkowitz, H. L. Hoboken, NJ; Stevens Inst. of Tech. (1972). 59p. University Microfilms Order No. 72-31,159.

Thesis.

A method for the approximate solution of the Klein–Gordon and Dirac equations for charged particles in the presence of two electromagnetic, noncollinear, transverse plane waves has been developed. The solution to the Klein–Gordon equation is a product of functions which are either solutions to linear, ordinary differential equations of the Hill type or solutions to a Volkov equation. It is shown that solutions to the Dirac equation can be constructed from sums of functions similar to those mentioned above. The mass-energy relation in this approximation has a complicated dependence on the field strengths and particle momentum. In particular, it is found that a slowly moving particle in an intense standing electromagnetic wave has a mass shift of order V^2/C^2 times that given by second order perturbation theory. Here V is the component of particle velocity perpendicular to the direction of "propagation" of the waves. (Diss. Abstr. Int., B)

13128 MODELS OF DIFFRACTIVE PRODUCTION PROCESSES ON SIMPLE AND COMPOSITE TARGETS. Czyz, W. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol.; B3: No. 6, 663-78(1972).

A unified description of diffractive production processes on nucleons and nuclei based on a model proposed some time ago by Bialas, Kotański and the author is discussed. (auth)

13129 DIFFRACTIVE DISSOCIATION IN INCLUSIVE REACTIONS. C. M. (Rutherford Lab., Chilton, Eng.). Acta Phys. Pol.; B3: No. 6, 879-88(1972).

General features of diffractive dissociation in inclusive reaction are discussed especially in the case when it dominates the high energy total cross section. (auth)

Electromagnetic

Refer also to abstracts 13296, 13308, and 13316.

13130 (COO-1764-151) QUARK LOOP DYNAMICS AND MESON DECAYS. Suura, H.; Young, Bing-Lin (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 30p. (DESY-72/3). Dep. NTIS.

From a set of lowest order quark loop diagrams for static mesionic amplitudes involving vector and axial-vector vertices,

the effective quark mass and the meson-quark-quark coupling constants for three types of quark models are determined. These parameters are applied to evaluate certain mesonic decays and the SU_3 mass splitting of 0^- octet and 1^- nonet, which serve as tests for the quark models. Adler's low energy theorem for the $\pi^0 \rightarrow 2\gamma$ decay is derived in this approach without invoking the Adler–Schwinger anomaly. The test favors the Nambu–Han model of integrally charged quarks. Critical examinations of the underlying assumption of the quark loop dominance are made, and a speculation on a physical model which allows such a situation is proposed. (auth)

13131 (COO-1764-152) TESTING TRIPLET MODELS. Suura, H.; Walsh, T. F.; Young, B.-L. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1972. 10p. (DESY-72/21). Dep. NTIS.

The radiative decays of mesons are used to test the Han–Nambu and Gell–Mann–Zweig quark models. Several tests are given which can distinguish these two models. (JFP)

13132 (COO-1764-160) TWO PION INTERMEDIATE STATES IN THE DECAY $K_S^0 \rightarrow 2\gamma$. Goble, R. L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1972. Contract AT(11-1)-1764. 9p. Dep. NTIS.

The unitarity relations for the two-pion intermediate state in the decay $K_S^0 \rightarrow 2\gamma$ are solved using a recently derived form for the amplitude for the process $2\gamma \rightarrow 2\pi$, which keeps the exact one pion-exchange contribution, but neglects the left hand cut and inelastic cuts in the π-π scattering amplitude. The resulting amplitude shows no direct enhancement of the decay rate from strong interactions and the rate could be zero if the cross section for $2\gamma \rightarrow 2\pi$ were zero at the K mass. A plausible choice of the amplitude for $2\gamma \rightarrow 2\pi$ gives a contribution which has exactly the magnitude that would be calculated using perturbation theory for point-like pions with no strong interactions, but is shifted by the π-π scattering phase leading to a unitarity lower bound that is smaller by about a factor of two. (auth)

13133 (IC-72/151) MASS DISPERSION RELATIONS AND e^+–e^- COLLISIONS IN THE PHYSICS OF THE LIGHT CONE. Preparata, G. (International Centre for Theoretical Physics, Trieste (Italy)). Dec 1972. 71p. Dep. NTIS (U. S. Sales Only).

The lectures on light cone physics cover mass dispersion relations, the light cone with mass dispersion relations and vector meson dominance, mass dispersion relations and some problems of PCAC, the light cone and e^+e^- colliding beam physics, and crossing in light-cone physics. (JFP)

13134 (JINR-E2-6792) AUTOMODEL AND ON MASS SHELL ASYMPTOTICS ACCORDING TO THE DYSON–JOST–LEHMANN REPRESENTATION. Matveev, V. A.; Robashik, D.; Tavkhelidze, A. N.; Vitsorek, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 28p. Dep. NTIS (U. S. Sales Only).

On the basis of the Dyson–Jost–Lehmann representation the connection between the automodel behavior in deep inelastic scattering region and on-shell high-energy asymptotics is investigated. Weight functions are given which lead to automodel behavior for deep inelastic e-p scattering and to a constant total cross section for real Compton scattering. In general the corresponding weight functions $\psi(\tilde{u},\lambda^2)$ have singularities at $\tilde{u} = 0$ (in the sense of generalized functions) which determine the high energy behavior on the mass shell, whereas the automodel behavior depends on the λ^2 asymptotics of $\psi(\tilde{u},\lambda^2)$. Examples of causal structure functions exhibit the importance of the time-like region $q^2 > 0$ for the determination of the leading light cone singularity of the current commutator. (auth)

13135 DETERMINATION OF SCATTERING AMPLITUDE IN PROBLEMS INVOLVING TWO OR THREE CHARGED PARTICLES. Veselova, A. M. (Leningrad State Univ.). Teor. Mat. Fiz.; 13: No. 3, 368-76(Dec 1972). (In Russian).

Using Dollard's nonstationary approach to the definition of the S-matrix for particles with Coulomb interaction, the expressions of the two- and three-particle scattering amplitudes in terms of corresponding T-matrices are obtained. (auth)

13136 IMPLICATIONS OF GAUGE INVARIANCE FOR PION ELECTROPRODUCTION AT THRESHOLD. Benfatto, G. (Univ., Rome); Nicolo, F.; Rossi, G. C. Nucl. Phys.; B50: No. 1, 205-21(1972).

The implications of gauge invariance in the problem of the on-shell extrapolation of the electroproduction low-energy theorems are discussed. It is shown that there is an invariant amplitude which can be evaluated at the Breit threshold either using gauge invariance and on-shell dispersion relations or following the Fubini and Furlan extrapolation method starting from the current-algebra low-energy value of the amplitude. Comparing the two expressions, a relation between the electromagnetic pion form factor, $F_\pi(k^2)$, and the axial-vector nucleon form factors, $g_A(k^2)$ and $h_A(k^2)$ is found. (auth)

13137 INCLUSIVE PROPERTIES OF THE e^+e^- ANNIHILATION INTO HADRONS. Renard, F. M. (Departement de Physique Mathematique, Montpellier, France). Nucl. Phys.; B50: No. 1, 44-60(1972).

The reaction $e^+e^- \rightarrow$ hadrons is described on the basis of an hadronic structure for the photon. The structure functions of the inclusive reaction $e^+e^- \rightarrow h +$ anything describe then the parton constitution of the photon in the scaling limit. Various types of couplings and models are considered (global couplings with vector mesons, fundamental photon-parton-antiparton couplings with formation of jets or fans). Precise shapes for the inclusive spectra and multiplicity distributions are deduced. Detailed comparisons with hadronic collisions $A + B \rightarrow h +$ anything are proposed in the fragmentation, the phase space boundary and the pionization regions which could determine the nature of the partons and their interactions. (auth)

13138 APPLICATIONS OF THE QUARK PARTON MODEL IN ONE-PARTICLE INCLUSIVE LEPTONIC-INDUCED REACTIONS. Gronau, M.; Ravndal, F.; Zarmi, Y. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Nucl. Phys.; B51: 611-27 (1973).

The quark parton model is applied to the deep-inelastic region of single-particle inclusive lepton-hadron processes. The current-fragmentation region is mainly discussed. Various conclusions concerning experimentally observable quantities such as single-particle distribution functions and average multiplicities are reached. Sum rules such as the Bjorken and Adler sum rules are generalized in this case. The average multiplicities of current fragment pions in neutrino reactions are found to be independent of the target and of x. They are related to electroproduction multiplicities. A relationship is established between the $x \rightarrow 0$ limit of the latter, and pion multiplicities in e^+e^- annihilation. Assuming SU(3) invariance, relations among π and K multiplicities are derived. (auth)

13139 UNIFIED DESCRIPTION OF VECTOR-MESON PRODUCTION AND PSEUDOSCALAR-MESON PHOTOPRODUCTION WITH A REGGEIZED ABSORPTION MODEL AND VECTOR-MESON DOMINANCE. Alonso, J. L.; Schiff, D. (Laboratorie de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B51: 557-85(1973).

A unified description of vector-meson production and pseudoscalar-meson photoproduction is presented. An absorptive Regge-cut model is used to determine, from fits to $\pi N \rightarrow \omega N$, $\gamma N \rightarrow (\pi^0, \eta)N$ and $\pi^- p \rightarrow \rho^0 n$ data, the amplitudes of the absorbed Regge exchanges which are included in the analysis: ρ, B, ω, π, and A_2. VDM is used to relate neutral pseudoscalar-meson photoproduction to the corresponding hadronic processes. The Regge residues have NWS zeroes and constraints from VDM, SU(6) and EXD are imposed on the parameters. Predictions are given for $\rho^\pm$ production, in good agreement with the data. The possibility of predicting $\pi^\pm$ photoproduction through VDM is discussed. It is proposed that VDM be broken only in the pion contribution, but keeping the residue of the pole at $t = \mu^2$ fixed from ρ-production, which amounts to having the same elementary pion in processes related by VDM. (auth)

13140 DEEP INELASTIC PROCESSES IN LADDER MODELS. Altarelli, G. (Univ., Rome); Maiani, L. Nucl. Phys.; B51: 509-34(1973).

The structure functions of deep inelastic scattering and of deep inelastic annihilation of a current in the $g\phi^3$ theory are studied in the ladder approximation. To this aim an integral equation which is the scaling limit of the classical ABFST equation is used. By solving this equation in a particular case form the sum of all ladder diagrams with all massless rungs except for the first and the last ones which are given arbitrary masses is obtained in closed form. The resolution is a hypergeometric function in two variables and its analyticity properties in the scaling variable ω, for fixed values of the external mass, are studied. The structure function for annihilation turns out to be, in this case, the analytic continuation of the scattering structure function. Going beyond this particular solution it is shown in general from the integral equation that the average multiplicity of the secondary particles in the annihilation region approaches a finite limit for increasing q^2, q_μ being the four momentum of the current. Implications of this result for e^+e^- annihilation into hadrons are discussed. (auth)

13141 STUDY OF $\eta-\eta'$ MIXING. Gault, F. D. (Univ. of Durham, Eng.); Jones, H. F.; Scadron, M. D. Nucl. Phys.; B51: 353-64(1973).

The available experimental evidence on $\eta-\eta'$ mixing is discussed in an attempt to decide between the linear and quadratic schemes. The two-photon decays of pseudoscalar mesons tend to favor linear mixing, due to a recent lowering of the upper bound for the η' width. A_2 decays are inconclusive because of a large uncertainty in the branching ratio to $\eta'\pi$. Linear mixing is certainly not ruled out by high-energy production experiments. (auth)

13142 INTEGRAL BOUNDS ON THE TOTAL CROSS SECTIONS OF THE COMPTON SCATTERING AND THE ELECTRON–POSITRON ANNIHILATION INTO HADRONS. Baluni, V.; Dumbrais, O. V. (Moscow State Univ.). Nucl. Phys.; B51: 289-300(1973).

Integral bounds on the cross section of the Compton scattering are established making use of analyticity, crossing symmetry and unitarity. These bounds depend on the knowledge of the amplitude at energies lower than the pion mass. The analysis carried out on the basis of available experimental data on the total cross section indicates that the obtained relations are practically equalities. A brief investigation is also carried out with respect to the high-energy behavior of the cross section of the electron-positron annihilation into hadrons. (auth)

13143 APPLICATION OF DUALITY PRINCIPLES TO DEEP INELASTIC REACTIONS. Chaichian, M. (Univ., Hamburg); Kitakado, S.; Pallua, S.; Renner, B.; De Azcarraga, J. Nucl. Phys.; B51: 221-36(1973).

General constraints of duality are applied to deep-inelastic structure functions in a systematic manner. In analogy with hadronic duality two components are admitted: one being constrained to non-exotic SU_3 representations in two channels simultaneously, the other being a generalization of the pomeron effect. The results can be best interpreted in terms of a quark-parton model with the usual valence quarks and a sea of SU_3-singlet quark-antiquark pairs, and the results of that model are reproduced without having to deal with quarks explicitly. On the theoretical side a statement of exchange degeneracy on the light cone is given, and a speculative connection is obtained between the pomeron effect and the matrix elements of the quark kinetic-energy tensor. (auth)

13144 SUPPORT PROPERTIES OF THE SCALING FUNCTION FOR TIME-LIKE VIRTUAL PHOTONS. Bouchiat, C.; Fayet, P.; Meyer, Ph.; Sourlas, N. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B51: 109-15 (1973).

The support properties of the scaling function in the case of time-like virtual photons are studied in a very simple perturbative model. The cancellation mechanisms which insure the identity of the support for time-like and space-like photons are clearly exhibited. (auth)

13145 RADIATION FROM A NEUTRON MOVING THROUGH A MEDIUM IN A MAGNETIC FIELD. Kul'kin, A. G.; Pavlenko, Yu. G. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 135-41(1972). (In Russian).

Expressions were obtained for the intensity of the spontaneous emission from a neutron which moves in a medium through a magnetic field. The effects of orientation of spin in the initial and final states on the polarization, spectral distribution, and threshold of Cherenkov radiation, were considered. (tr-auth)

13146 INDUCED CHERENKOV ACCELERATION OF NEUTRONS. Kul'kin, A. G.; Pavlenko, Yu. G. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 240-2(1972). (In Russian).

Induced Cherenkov acceleration of neutrons was examined during the interaction with radiation of different polarization. The intensity of the Cherenkov radiation was considered for linear, right, and left handed circular polarization. Neutron interaction with a circularly polarized wave led to the same evaluation for the critical radiation density and energy increment. (K.S.W.)

13147 PECULIARITIES OF THE RADIATION FROM A CHARGE MOVING IN A MAGNETIC FIELD OF RANDOM CONFIGURATION. Ternov, I. M.; Bagrov, V. G.; Bordovitsyn, V. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 248-50 (1972). (In Russian).

A point charge moving through an external magnetic field, time-independent, along a plane trajectory was considered, and the field of radiation of such a charge at an arbitrary point was analyzed. The angular distribution of the radiation was independent of both the form of the trajectory and the configuration of the external field. (K.S.W.)

13148 SINGULAR SOLUTION OF THE SCHROEDINGER EQUATION IN CONSTANT HOMOGENEOUS ELECTRIC AND MAGNETIC FIELDS. Kuang, Tkhai Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 256-9(1972). (In Russian).

The Schroedinger equation for a charged particle with charge e and mass m in an electromagnetic field was manipulated so as to obtain a Green function of the Schroedinger equation in homogeneous, constant, and parallel electric and magnetic fields. (K.S.W.)

13149 ANOMALOUS SECONDARY EMISSION AT HIGH ENERGIES. Lorikyan, M. P.; Kavalov, R. L.; Trofimchuk, N. N. JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 226-8 (20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 320-4(20 Sep 1972).

The results of an investigation of the anomalous secondary electron emission at high energies as a function of the film thickness, of the distance between grid and film, and of the potential of the drawing grid are reported for relativistic electrons passing through a dielectric film. (J.F.P.)

13150 PHOTOPRODUCTION OF CHARGE PIONS ON NUCLEI AND VIOLATION OF THE VECTOR DOMINANCE MODEL. Gevorkyan, S. R.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 296-8(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 418-20(5 Oct 1972).

The cross sections for π^+ photoproduction on nuclei are calculated within the framework of the vector dominance model and are compared with experiment. It is shown that a more accurate allowance for the energy dependence of the effective nucleon numbers, together with allowance for the violation of the vector dominance model, result in the best agreement between theory and experiment. It is suggested that this agreement confirms the correctness of the fundamental principles on which the theory of incoherent processes is based. (L.B.S.)

13151 ELECTROMAGNETIC CURRENT AND CHARGE DUE TO INTERACTION BETWEEN A GRAVITATIONAL AND A FREE ELECTROMAGNETIC FIELD. Zel'dovich, Ya. B. (Inst. of Applied Mathematics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 302-4(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 425-7(5 Oct 1972).

The following result is formulated and discussed: A gravitational field interacting with an electromagnetic one produces a definite charge and current density distributed in space and linearly dependent on the electromagnetic field. This charge density is produced in the absence of any particles, and is the result of the interaction of two truly-neutral fields, and thereby differs from all the charge variants considered heretofore. (L.B.S.)

13152 NONSTATIONARY REGULAR SOLENOIDAL FLOW OF PARTICLES OF LIKE CHARGE IN AN ARBITRARY MAGNETIC FIELD. Ogorodnikov, S. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1076-82(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1348-56(Jul 1972).

The theory of functions of a complex variable is used to examine the nonrelativistic nonstationary regular solenoidal flow of particles of like charge in an arbitrary magnetic field. The general equation for such flow is obtained. The magnetic self-field and the displacement current are neglected; the space charge is assumed to be different from zero. Essentially different solutions of the general equation are presented and the main characteristics of the flows are indicated.

13153 BROKEN SYMMETRY QUARK MODEL FOR NEUTRON CHARGE FORM FACTOR. Friar, J. L. (Massachusetts Inst. of Tech., Cambridge). Particles Nucl.; 4: No. 4, 153-62 (Oct 1972).

Symmetry breaking is introduced within the framework of the symmetric quark model in order to generate a non-vanishing neutron charge form factor. A space-symmetric wave function is first introduced which reproduces the (approximate) dipole form for the proton charge form factor. This symmetry is then broken in a way which naturally leads to a non-vanishing neutron charge form factor. The resulting prediction is in excellent agreement with recent data deduced from elastic electron–deuteron scattering. (auth)

13154 CONFORMAL SYMMETRY AT LIGHTLIKE DISTANCES AND ASYMPTOTIC BEHAVIOR OF ELECTROMAGNETIC FORM

FACTORS. Ferrara, S.; Grillo, A. F.; Parisi, G. (CNEN, Frascati, Italy). Nuovo Cim.; 12A: No. 4, 952-8(21 Dec 1972).

Using conformal symmetry for the operator product of the hadronic electromagnetic current and the pion interpolating field, at lightlike distances, the behavior of the structure function in the scaling limit is connected to the on-mass-shell asymptotic behavior of the electromagnetic pion form factor. The results are based on the analysis of the dimension spectrum of local operators appearing in the operator product expansion and on the assumption of precocious scaling. As an application of the results, predictions on the asymptotic behavior of the e.m. pion form factor as well as for the threshold behavior of the structure function for the singly inclusive π production in e^+e^- annihilation are given. (auth)

13155 VECTOR-MESON DOMINANCE AND ELECTROMAGNETIC INTERACTIONS IN RELATIVISTIC QUARK MODELS. Gonzalez, M. A.; Watson, P. J. S. (Univ. of Guelph, Ont.). Nuovo Cim.; 12A: No. 4, 889-908(21 Dec 1972).

Several covariant quark models based on the Bethe–Salpeter equation are discussed for the purpose of studying electromagnetic interactions. All the models have faults, but the most satisfactory model implies vector-meson dominance for the electromagnetic vertex, and hence it should be included in phenomenological applications of the quark model. It is shown that the instantaneous interaction, considered by a number of authors, leads to a complex form factor, and that an infinitely retarded interaction is even less satisfactory. In the context of the four-dimensional oscillator, it is shown that daughter vector states do not couple to the electromagnetic current, and that the model obeys the correct threshold relations for the production form factor for a spin-1 resonance. (auth)

13156 ELECTROPRODUCTION AT THE N*(1236). Cochard, G.; Karatchentzeff, M.; Kessler, P.; Roehner, B. (College de France, Paris). Nuovo Cim.; 12A: No. 4, 909-26(21 Dec 1972).

Electroproduction of pions is calculated at the mass shell of the N*(1236) in a model where seven Feynman diagrams are used, namely the direct isobar term, the crossed isobar term, the three Born terms, terms with ρ and ω exchange. Three parameters, i.e. coupling constants for the γNN^*, ρNN and ωNN vertices, were obtained through a best fit of the angular distributions in photoproduction of π^+ and π^0. On the other hand, a universal electromagnetic form factor of the dipole type was used at all vertices connecting the virtual photon with hadrons. Recent results of single-arm and double-arm experiments on electroproduction of pions are fitted with this model, and the agreement is satisfactory. It is noticed that the value found for the magnetic-dipole moment of the γNN^* vertex is in very good agreement with the SU_6 prediction. (auth)

13157 UNIVERSALITY OF THE FORM FACTORS AND THE STRUCTURE FUNCTIONS IN THE DYNAMICAL RESONANCE MODEL. Niegawa, A. (Kyoto Univ.). Nuovo Cim.; 12A: No. 4, 1038-48(21 Dec 1972).

A study is made of the analytic properties of the form factor and the virtual-Compton-scattering amplitude for a meson target of any spin obtained from the dynamical resonance model proposed by Manassah and Matsuda. The resultant form factors and the structure functions have the remarkable property of universality. That is, the form factor $F(q^2)$ and the electroproduction scaling function $F_2(\omega) \equiv \nu W_2$ have no target meson spin dependence. (auth)

13158 HOW TO TEST THE ALGEBRA OF BILOCAL CURRENTS. Fritzsch, H. (CERN, Geneva). Nuovo Cim.; 12A: No. 4, 1016-24(21 Dec 1972).

The possibility of testing the algebra of bilocal currents as abstracted from the quark model by the use of deep inelastic electroproduction of massive muon pairs. (auth)

13159 LOW-ENERGY PION PHOTO- AND ELECTROPRODUCTION IN A DUAL RELATIVISTIC QUARK MODEL. Venturi, G. (Univ., Bologna). Nuovo Cim.; 12A: No. 4, 1065-79(21 Dec 1972).

A dual relativistic quark model is constructed for pion photo- and electroproduction. It has a satisfactory high-energy behavior, and a quark model mass spectrum and factorization properties on the leading trajectory. The introduction of U_6 symmetry breaking for the exchanged trajectories is examined in detail and the gauge invariance constraints are also discussed. The low-energy properties of the model are compared with the algebra of currents predictions and experiment. (auth)

13160 BJORKEN'S ASYMPTOTIC SCALING, CONVERGENT ELECTROMAGNETIC SELF-MASS OF HADRONS AND OPERATOR PRODUCT EXPANSION. Morita, K. (Dalhousie Univ., Halifax, Nova Scotia). Nuovo Cim.; 13A: No. 1, 271-90(1 Jan 1973).

General criteria on the finiteness of the electromagnetic self-mass of hadrons are derived on the basis of Bjorken's asymptotic scaling. It is shown that, if such criteria are really obeyed, the space-space components of the equal-time commutator function of the electromagnetic current with its first time derivative are completely determined by the Bjorken limits of the electroproduction structure functions. A configuration-space description of the results is presented, making use of the operator product expansion near the light-cone. (auth)

13161 DUALITY AND ELECTROPRODUCTION. Brandt, R. A.; Ng, W. C. (New York Univ., NY). Nuovo Cim.; 13A: No. 1, 153-71(1 Jan 1973).

A two-component duality framework for electroproduction is proposed in which the resonance contribution W^R to νW_2 is dual to the tensor Regge trajectories (f^0,A_2) and the background contribution W^B is dual to the sum of the pomeron trajectory and a suitably defined fixed ($J = 0$) pole extrapolation. The framework is seen to be consistent with the SLAC data and with resonance models. Consistency with locality (causality) is implemented by the use of the locality sum rules which were recently derived and which are in very good agreement with experiment. Locality, with some other assumptions, is shown to imply a universal fall-off rate $(-q^2)^{-d}$ for excitation form factors and the connection $2d = p + 1$ with the threshold behavior $(1 - \omega)^p$ of the scaling function $F_2(\omega)$. It is argued that W^R is not local, so that neither is W^B. Fixed-pole extrapolations consistent with these restrictions are exhibited. (auth)

13162 RADIATION BY RELATIVISTIC PARTICLES IN PERIODIC STRUCTURES. Baier, V. N.; Katkov, V. M.; Strakhovenko, V. M. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz.; 63: No. 6, 2121-31(Dec 1972). (In Russian).

Radiation by relativistic electrons moving in a periodic external electromagnetic field is considered. Polarization, spectral and angular characteristics of the radiation are obtained. The region in which quantum effects are important is considered. It is shown that the operator quasiclassical method previously proposed is also valid in the case of strongly inhomogeneous fields. Some possible experiments are discussed. (auth)

13163 NUMBER OPERATOR FOR PHOTONS TRAVERSING A SPATIAL POINT. Tatarskii, V. I. (Inst. of Atmospheric Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 6, 2077-81 (Dec 1972). (In Russian).

The quantum mechanics operator corresponding to the number of photons traversing a spatial point for an infinite time is determined. (auth)

13164 TEST OF LIGHT-CONE BILOCAL ALGEBRA OF CURRENTS IN THE UNIFIED THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Murtaza, G. (Univ. of Toronto). Lett. Nuovo Cim.; 6: No. 1, 29-35(6 Jan 1973).

A study is made of the deep inelastic semi-inclusive vector meson production process $e + N \rightarrow e +$ vector meson + anything. This provides a circumstance where the cross section is determined by a commutator of two commutators of local currents and therefore tests the bilocal algebra on the light cone. The behavior of the structure tensor is considered. (JFP)

13165 CHARGED-PARTICLE MOTION IN SUPERSTRONG ELECTROMAGNETIC FIELDS. Grewing, M. (Univ., Bonn); Heintzmann, H. Phys. Lett.; 42A: No. 4, 325-6(18 Dec 1972).

The motion of charged particles in superstrong electromagnetic fields is studied analytically and numerically. An analytic solution is given for constant fields which also describes satisfactorily the initial part of the motion in the slowly varying fields surrounding a pulsar. (auth)

13166 COMPUTER STUDY OF THE PROTON–ELECTRON–POSITRON SYSTEM BY A VARIATIONAL METHOD. Arifov, P. U.; Mal'yan, V. M. pp 68-73 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

Test functions ψ of various types were examined on a computer to minimize the energy functional $E = \int \psi^* H \psi d\tau / \int |\psi|^2 d\tau$. Results for the first three test functions indicate that the pe^+e^- system should be regarded as an analog of the negative H ion, rather than the He atom. Minimum energies of -0.314 and -0.38843 au indicate stability against decomposition into proton + positronium or positron + excited H atom, but instability against decomposition into positron + H atom in ground state. The electron density distribution of pe^-e^+ is compared with that for pe^-e^-. The identification of the state of ψ_5 is discussed. (DLC)

Weak

Refer also to abstracts 13278 and 13280.

13167 (BNL-17469) HYPERON PHYSICS FOR PEDESTRIANS. Marx, Jay (Brookhaven National Lab., Upton, N. Y.). 30 Nov 1972. 24p. Dep. NTIS.

With the advent of high energy hyperon beams, accurate measurements of the properties of hyperons will become commonplace. Several important predictions of the simple quark model for hyperon decays and interactions are discussed. This pedagogical discussion is used to motivate an appreciation of the importance of hyperon beams in studies of elementary particles. A description of the Yale/NAL/BNL hyperon beam at the AGS is presented. (auth)

13168 (JINR-E2-6722) SUM RULES FOR THE PHOTON-LEPTON INTERACTION CROSS-SECTIONS. Gerasimov, S. B.; Mulen, Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 12p. Dep. NTIS (U. S. Sales Only).

The relativistic dipole moment fluctuation sum rules for a free lepton and for a lepton bound in a Coulomb field are derived and checked in the lowest order of perturbation theory. The dispersion sum rule for the anomalous magnetic moment is applied to estimate the influence of a possible existence of heavy "excited" leptons on the electron and muon magnetic moments. (auth)

13169 CRITICISM OF ROSS' MUON MODEL. Waller, R. G. (Univ. of Lancaster, Eng.). Lett. Nuovo Cim.; 5: No. 16, 1030-2 (16 Dec 1972).

A model was previously proposed by Ross, which treated the muon as a gravitationally bound state of an electron and a massless spin-one particle. In this model it was claimed that the muon mass had been predicted. It is argued that this claim is invalid, and that the general-relativistic calculations contain several flaws, of which one at least is so serious as to render the whole argument meaningless, in so far as it relates to gravity. (L.B.S.)

13170 LEPTON AND RADIATION-LEPTON DECAYS OF NEUTRAL VECTOR MESONS ALLOWING FOR POLARIZATION EFFECTS. Kerimov, B. K.; Tsvetkov, V. P.; Ablakulov, Kh. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 219-28 (1972). (In Russian).

Expressions were obtained for the probability of lepton and radiative lepton decays of the vector meson $V \to 1^+1^-$ and $V \to 1^+1^-\gamma$ taking into account polarized correlations of particles. During the decay of a vector meson, possessing dipole polarization, electrons with a positive spirality e^-_R, and electrons e^-_L (positrons = e^+_R), and photons polarized circularly left, are contrary to the direction of the polarization of a V-meson vector. (tr-auth)

13171 HIGHER-ORDER CORRECTIONS IN MUON DECAY. Ross, D. A. (Oxford Univ.). Nucl. Phys.; B51: 116-24(1973).

The second-order weak and electromagnetic corrections to the decay rate of the muon are calculated from Weinberg's model of leptons. The calculation is performed in a manifestly renormalizable gauge. (auth)

13172 CP VIOLATION IN DECAYS OF NEUTRAL K-MESONS. Bilen'kii, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 146-64 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

The problem of CP-invariance violation in the decays of neutral K-mesons is reviewed. An effective equation for the system, described by the superposition of K^0- and $\overline{K}^0$-states, is discussed. The $K_L \to 2\pi$ decays and the lepton decays of K_L-mesons are considered. The model of the superweak interaction is discussed. (auth)

13173 WHAT IS THE PENETRATING ABILITY OF THE NEUTRINO? Mikaelyan, L. A. JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 221-2(20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 313-14(20 Sep 1972).

The energy loss mechanisms and mean free paths of solar neutrinos are discussed. (J.F.P.)

13174 FORMULATION OF THE WEINBERG'S MODEL OF LEPTONS BASED ON THE TRIPLET REPRESENTATION. Sato, H. (Tokyo Univ.). Lett. Nuovo Cim.; 5: No. 17, 1083-6(23 Dec 1972).

It is shown that Weinberg's model of leptons can be formulated on the basis of the triplet representation for leptons and that the electron and the muon can be treated in a symmetric and unified way. (L.B.S.)

13175 NONCONVENTIONAL PROCESSES IN ANOMALOUS COSMIC-RAY EXPERIMENTS. Bergamasco, L. (CRN, Turin); Castagnoli, C.; D'Ettorre Piazzoli, B.; Picchi, P. Lett. Nuovo Cim.; 5: No. 17, 1079-82(23 Dec 1972).

Four experiments carried out in different technical and environmental situations have given unexpected and anomalous results: the horizontal air showers of the Tokyo group; the muon-poor showers of the Lodz group; the muon angular distribution at great depth of the Utah group; and the overabundance of the stopping muons at 4270 MW(e) of the Torino group. All four anomalous experiments are coherently interpreted under the hypothesis of a new heavy particle of mass ~40 GeV, which has several features common to Weinberg's boson. (L.B.S.)

13176 DENSITY MATRIX IN THE PRODUCTION OF N* BY NEUTRINOS. Lee, M. H.; Song, H. S. (Seoul National Univ.). New Phys. (S. Korea); 12: No. 2, 35-7(Jun 1972). (In Korean).

Explicit values of density matrix elements in the process $\nu_l + p \to N^* + l$ are obtained when three form factors obtained by Berman and Veltman and by Albright and Liu are used. It is found that $\rho^3/_2$, $1/_2$, and $\rho^3/_2$, $-1/_2$ along the direction of incident proton in the Gottfried-Jackson system vanishes. (auth)

13177 W BOSON PRODUCTION AND ETA DECAYS. Pratap, M. Stony Brook, NY; State Univ. of New York (1972). 108p. University Microfilms Order No. 72-29,255.

Thesis.

The present thesis is divided into two parts. In part I, W boson production via muon beams is discussed. The relevant reactions are $\mu + Z \to \nu + Z + W$ (projectile fragmentation) and $\mu + p \to \mu + n + W$ (target fragmentation). Using a model where an attempt is made to introduce strong interaction effects via phenomenological form factors, the target fragmentation process is studied, concentrating on energies and W boson masses appropriate to the National Accelerator Laboratory. Total cross sections and angular and energy distributions are given for the W boson and final muon and these results are compared with those obtained in the projectile fragmentation reaction. Eta and pion decays into lepton pairs is the subject matter of part II. A recent measurement of branching ratio $\Gamma(\eta \to \mu^+\mu^-)/\Gamma(\eta \to \text{all})$ yielded the value $(5.9 \pm 2.2) \times 10^{-5}$. The implication of this result on theoretical predictions for the real part of the $\eta \to \mu^+\mu^-$ decay amplitude is examined and it is concluded that the branching ratio is uncomfortably large for most of the models proposed so far. The $\eta \to \mu^+\mu^-$ decay rate is evaluated in the baryon loop model. Predictions are also made for the associated decays $\eta \to \gamma\mu^+\mu^-$, $\pi^0 \to e^+e^-$, $\pi^0 \to \gamma e^+e^-$. (Diss. Abstr. Int., B)

13178 EFFECTIVE LAGRANGIAN APPROACH TO RADIATIVE K MESON DECAYS. Sarraga, R. F. Evanston, IL; Northwestern Univ. (1972). 161p. University Microfilms Order No. 72-32,561.

Thesis.

A model is constructed to study the combined effects of the strong, hadronic electromagnetic, and weak nonleptonic interactions in radiative K-meson decays. Effective Lagrangians are employed and all calculations are performed in the tree approximation. The strong-interaction Lagrangian contains SU(3) × SU(3) vector and axial-vector gauge fields and leads to the current commutation relations of the algebra of fields. The model also includes spin-0 fields in the $(3,3^*) + (3^*,3)$ representation, but the scalar and the SU(3)-singlet pseudoscalar fields are made nonlinear functions of the octet $J^P = 0^-$ fields. The Lagrangian involves SU(3)-invariant axial-vector-pseudoscalar mixing, which results in axial currents dominated by both $J^P = 1^+$ and $J^P = 0^-$ fields. The nonleptonic weak-interaction Lagrangian is formed from the $|\Delta S| = 1$, CP-invariant product of the V-A currents resulting from the strong Lagrangian. Three possibilities are considered: (a) a pure octet, (b) an octet and a 27 with $\Delta I = {}^1/_2$, and (c) an octet plus two 27 pieces with $\Delta I = {}^1/_2$ and $\Delta I = {}^3/_2$. The hadronic electromagnetic interaction is introduced using the gauge invariant method of Kroll, Lee, and Zumino. A comprehensive study is made of the effective-Lagrangian approach to radiative K-meson decays. With our model the best results are obtained with the weak interaction of type (b). A fit was obtained for the decays $K^0_1 \to 2\pi$, $K^0_1 \to \gamma\gamma$, and the measured upper bounds for $K^+ \to \pi^+l\bar{l}$, while obtaining predictions for the $K^0_2 \to l\bar{l}$ rates. The weak interaction of type (a) fits the radiative models if $K^0_1 \to 2\pi$ is disregarded, while the weak coupling of type (c) cannot fit $K^+ \to \pi^+\pi^0$, $K^0_1 \to 2\pi$, and the radiative modes simultaneously. (Diss. Abstr. Int., B)

13179 CALCULATION OF THE K_{l2} AND K_{l3} DECAY FORM FACTORS THROUGH SIMILARITY TRANSFORMATIONS. Eberle, E. (Univ., Genoa). Nuovo Cim.; 12A: No. 4, 990-6(21 Dec 1972).

The K_{l2} and K_{l3} decays are related to the π_{l2} and π_{l3} decays respectively. This is achieved through the use of similarity scale transformations here used in the sense of the theory of models. (auth)

13180 POSSIBLE INCONSISTENCIES IN CALCULATIONS OF SEMI-LEPTONIC PROCESSES INVOLVING CHARGED HIGGS–KIBBLE SCALARS. Ross, D. A.; Sarkar, S. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 6: No. 1, 1-4(6 Jan 1973).

The Lee–Prentki–Zumino model is considered for kaon two- and three-body leptonic decays. The ratio f_K/f_π is calculated from the model giving an upper limit of 0.75 which is very badly in disagreement with experiment. Thus it is found that there is no consistent way of calculating K decays. (JFP)

13181 K_{l3} FORM FACTORS FROM CURRENT ALGEBRA. Ecker, G. (CERN, Geneva). Nuovo Cim.; 13A: No. 1, 291-310 (1 Jan 1973).

Including some straightforward consequences of analyticity and unitarity in the hard-meson current algebra approach, predictions are made for K_{l3} decays with a minimal set of assumptions. Consequences of a possible disagreement between theory and experiment are discussed. Making additional assumptions about the convergence properties of certain spectral functions, the relation $F_\pi^2 = F_K^2$ is derived without PCAC, pole dominance of spectral functions, or a specific type of $SU_3 \times SU_3$ symmetry breaking. (auth)

13182 MUON DECAYS UNDERGROUND AND THE UTAH EFFECT. Keuffel, J. W. (Univ. of Utah, Salt Lake City). pp 1385-90 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol. 4).

The Turin observation of a high rate of muon decays underground implies a flux of quasi-isotropic slow particles sufficient to resolve the discrepancy between muon zenith-angle distributions observed with thin detectors and the distribution observed with the Utah detector. Processes which might account for the Turin effect are discussed. (auth)

13183 MUON PRODUCTION MODELS FOR THE UTAH EFFECT. Carlson, G. W.; Keuffel, J. W.; Morrison, J. L. (Univ. of Utah, Salt Lake City). pp 1412-17 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol. 4).

Models of muon production were fitted to Utah and vertical underground muon intensities. Assuming a single spectral index for pions and kaons at production gave an acceptable fit to the π and K-derived muon component. The X-component was fit with several models. The most attractive of these involves underground absorption of X-component muons. This model accounts for a remarkable variety of phenomena. (auth)

Strong (General)

Refer also to abstract 13324.

13184 (COO–1764-149) SELF-TRAPPING FIELD OF QUARKS IN HADRONS. Suura, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 9p. (DESY-72/7). Dep. NTIS.

A formulation is given for a physical situation in which a large self mass of quarks acts as a trapping barrier for bare quarks. A vector cohesive field in a hadron is considered in the classical limit and a proper field is assumed to be three dimensional. From 1/r expansion of the self-field of the quark an asymptotic hadron mass spectrum follows almost uniquely. In the limit of an infinitely heavy quark, the mass spectrum reduces to that of a single four-point Veneziano amplitude. (auth)

13185 (COO–1764-157) COMPULSORY RESONANCE FORMATION. Rosner, J. L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1972. Contract AT(11-1)-1764. 10p. Dep. NTIS.

It is noted that if two mesons are allowed by the quark model to resonate, they do so for $p^* \leq p_0^{MM} \equiv 350$ MeV/c. The corresponding value for meson-baryon systems is $p_0^{MB} \equiv 250$ MeV/c, suggesting (in an optical picture) that the baryon is indeed bigger than the meson. Crucial tests of the rule are provided by exotic baryon–antibaryon systems, for which one expects $p_0^{BB} \cong 200$ MeV/c, and by other specific two-body modes which are predicted to resonate not far above threshold. (auth)

13186 (JINR-P2-6677) PROBLEM OF THE $h \to 0$ LIMIT IN A QUASIPOTENTIAL EQUATION. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The quasiclassical limit $h \to 0$ in a quasipotential equation is studied. The connection of this approximation with the eikonal one is considered. (auth)

13187 (RLO-2041-74) FRAGMENTATION IN THE CENTRAL REGION: POSSIBILITY OF A DISCONTINUITY AT x = 0. Hwa, R. C.; Zucker, P. A. (Oregon Univ., Eugene. Inst. of Theoretical Science. Stanford Linear Accelerator Center, Calif.). Jul 1972. 15p. (CONF-720954-1; SLAC-PUB-1073). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

The question of whether there may exist a discontinuity at x = 0 in the pion spectrum of an inclusive reaction initiated by two unequal particles is raised. While such an occurrence is impossible in a model with only short-range correlations, it is a distinct possibility in the diffractive excitation model when the energy is high enough. The discontinuity is related to the properties of the spectra of single diffractive excitations. Arguments are given as to why the discontinuity, if it exists, is not likely to be substantial. (auth)

13188 (RLO-2041-81) DIFFRACTIVE EXCITATION MODEL. Hwa, R. C. (Oregon Univ., Eugene). 1972. Contract AT(45-1)-2041. 13p. (CONF-720419-6). Dep. NTIS.

From 4th international conference on high energy collisions; Oxford, England (5 Apr 1972).

The discussion of the diffractive excitation model for multiparticle production processes, the model having fireball excitation and decay into pions and being an extension of diffraction dissociation and limiting fragmentation, covers pomeron bootstrap, the diffraction peak, limiting $\sigma_n(s)$, excitation, proton, and pion spectra, average pion multiplicity, the distribution at wee x, and the two-particle correlation. (JFP)

13189 RELATIONS BETWEEN DIFFERENTIAL CROSS SECTIONS FOR THREE-BODY REACTIONS FROM THE QUARK MODEL. Klosinski, J. (Univ., Lodz, Poland). Nucl. Phys.; B50: No. 1, 407-36(1972).

Relations among the differential cross sections for three-body processes following from the nonrelativistic quark model are classified and compared with experimental data. In general, within the experimental errors, they show satisfactory agreement, except relations for strangeness-exchange processes, namely so called SU(6) relations and relations following from the assumption of identity of quarks constituting mesons and baryons. The relation of these predictions to those of other models, and this investigation to a previous analysis of quasi-two-body reactions in the quark model is discussed briefly. (auth)

13190 FACTORIZATION OF THE POMERON SECTOR AND CURRENTS IN THE DUAL RESONANCE MODEL. Cremmer, E.; Scherk, J. (CERN, Geneva). Nucl. Phys.; B50: No. 1, 222-52 (1972).

The pomeron sector of the dual resonance model is exhibited by an explicit factorization of the nonplanar orientable one-loop graph. A pomeron propagator and a pomeron-reggeon vertex are obtained. The pomeron propagator is shown to be essentially the same as in the Shapiro-Virasoro model. Gauge properties of the pomeron-reggeon vertex allow one to construct conserved or partially conserved vector and tensor currents of arbitrary rank and to exhibit a ghost-killing mechanism. (auth)

13191 MESONS AS A RELATIVISTIC FERMI-QUARK–ANTIQUARK SYSTEM WITH STRONG BINDING. Boehm, M. (Univ., Wuerzburg, Ger.); Joos, H.; Krammer, M. Nucl. Phys.; B51: 397-433(1973).

A quark model with heavy spin ½ quarks is discussed for the mesons with the help of a Bethe–Salpeter equation for the amplitudes $\langle 0|T\psi_\alpha(\frac{1}{2}x)\bar{\psi}_\beta(-\frac{1}{2}x)|^{M_j\pi C}_{p_i}\rangle$ where $\psi,\bar{\psi}$ denote covariant Dirac quark fields. The Wick-rotated BS equation with harmonic kernels of convolution type with general spin dependence is solved, starting from a new class of exact solutions of the O(4) symmetric bound state mass-zero case. It is shown that an interaction of the P+ V – S type reproduces the low-mass mesons of the non-relativistic quark model lying on linear Regge trajectories. A complete list of the covariant, field theoretically normalized BS amplitudes for all mesons is given. As a first application, the decay constant of the pion, f_π, and the leptonic decay constants of the vector mesons, γ_V, are calculated; f_π depends on the quark mass and is for heavy quarks consistent with PCAC. (auth)

13192 PROBABILITY DESCRIPTION OF HIGH-ENERGY SCATTERING AND THE SMOOTH QUASI-POTENTIAL. Logunov,

A. A.; Khrustalev, O. A. (Inst. of High Energy Physics, Serpukhov, USSR). pp 39-51 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

The relation between the probability and quasi-potential descriptions of high energy scattering is studied. It is shown that the probability description of scattering can be considered as a justification for the introduction of smooth quasi-potentials into quantum field theory. (auth)

13193 POSSIBILITY OF ELECTROMAGNETIC DOMINANCE NEAR THE KINEMATIC LIMIT OF A HADRON SPECTRUM. Pirogov, Yu. F.; Ter-Isaakyan, N. L.; Khoze, V. A. JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 287-90(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 406-10(5 Oct 1972).

The asymptotic distributions near the boundary of phase space in the theory of inelastic hadronic processes is investigated using the quasi-two-particle phenomenology in which the problem is reduced to a determination of three-Reggeon constants. The interference of the hadronic and electromagnetic mechanism in the region where the contribution of electromagnetic effects become appreciable is examined. (L.B.S.)

13194 DEGENERACY BREAKING IN THE DUAL-RESONANCE MODEL. Roy, T.; Chowdhury, A. R. (Jadavpur Univ., Calcutta). Lett. Nuovo Cim.; 5: No. 17, 1073-8(23 Dec 1972).

A formalism is presented for breaking the degeneracies of physical trajectories in the Veneziano model by exploiting the knowledge that the eigenvectors of the crossing matrices, the basic ingredient for construction of dual amplitudes, are known from the knowledge of the crossing connections. The case of two isovector spinless mesons scattering is first considered. It is then demonstrated how the formalism can be extended to the case of SU(3) symmetry. The case of $\pi-\Sigma$ scattering is also considered. (L.B.S.)

13195 REGIONS OF NUCLEAR INTERACTIONS FROM DATA OF INELASTIC COLLISIONS. Takibaev, Zh. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 1-9(1972). (In Russian).

The structure of the field of strong interactions was analyzed on the basis of inelastic collision data. Hadron production with various quantum numbers was examined, and also with masses in the regions with different parameters. (tr-auth)

13196 t-CHANNEL DESCRIPTION OF THE ABSORPTION MODEL. Mukherji, N. Riverside, CA; Univ. of California (1972). 49p. University Microfilms Order No. 72-31,497.

Thesis.

The effect of introducing a branch point singularity in the j-plane of the D-function of a partial wave amplitude is studied for two specific cases: the square root and the logarithmic. The amplitude in both cases has complex conjugate poles, either in the physical sheet or in the unphysical sheet depending on the sign of the coefficient of the branch point singularity. Using the K-matrix method for the amplitude predicted by the strong Regge cut Model, an amplitude consistent with t-channel unitarity is obtained. This amplitude is found to have complex conjugate Regge poles, $\alpha_R \pm i\alpha_I$, for $t \leq 0$ in the physical sheet of the j-plane. Its j-plane discontinuity has a sharp peak at $j = \alpha_R$. The contribution of the discontinuity near the tip of the cut, $j = \alpha C$, as well as the problem of approximating the entire discontinuity integral by complex poles are discussed. (Diss. Abstr. Int., B)

13197 LIGHT-CONE PHYSICS AND DUALITY. Del Giudice, E.; Di Vecchia, P.; Fubini, S.; Musto, R. (Massachusetts Inst. of Tech., Cambridge). Nuovo Cim.; 12A: No. 4, 813-62(21 Dec 1972).

An attempt is made to grasp some features of hadron physics in terms of light-cone properties. Hadrons are considered, in the light-cone asymptotism, as aggregates of free massless quarks, aligned on the same direction (collinearity). The hadron states are classified by a representation of an $O_{2,1}$ algebra, constructed from the generators of the conformal group. Deep inelastic structure functions are evaluated and discussed. Analogies between duality and light-cone physics are stressed. (auth)

13198 TRANSVERSE-MOMENTUM DISTRIBUTION IN DUAL RESONANT MODELS. Di Giacomo, A.; Konishi, K. I. (Massachusetts Inst. of Tech., Cambridge). Nuovo Cim.; 12A: No. 4, 927-51 (21 Dec 1972).

It is shown that under the hypothesis that multiplicity is not larger than ln s, transverse momentum is exponentially cut off in DRM, beyond the tree approximation. Qualitative arguments are given showing that the above hypothesis is verified by the model. (auth)

13199 CURRENT ALGEBRA SUM RULES FOR REGGEONS. Carlitz, R. (CERN, Geneva). Nuovo Cim.; 12A: No. 4, 1049-64 (21 Dec 1972).

The interplay between the constraints of chiral $SU_2 \times SU_2$ symmetry and Regge asymptotic behavior is investigated. The derivation of various current algebra sum rules in a study of the reaction $\pi + \alpha \rightarrow \pi + \beta$ is reviewed. These sum rules imply that all particles may be classified in multiplets of $SU_2 \times SU_2$ and that each of these multiplets may contain linear combinations of an infinite number of physical states. Extending the study to the reaction $\pi + \alpha \rightarrow \pi + \beta$, new sum rules involving commutators of the axial charge with the reggeon coupling matrices of the ρ and f Regge trajectories are derived. Some applications of these new sum rules are noted, and the general utility of these and related sum rules is discussed. (auth)

13200 HIGH ENERGY THEOREMS FOR STRONG INTERACTIONS AND THEIR COMPARISON WITH EXPERIMENTAL DATA. Roy, S. M. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rep.; 5C: No. 3, 125-96(Nov 1972).

The high-energy theorems for strong-interaction scattering amplitudes based on analyticity in the domain derived from axiomatic field theory, crossing, and unitarity are reviewed and compared with experimental data. (L.B.S.)

13201 SYSTEMATICS FOR ELASTIC SCATTERING OF ELEMENTARY PARTICLES. Libby, L. M. (Univ. of California, Los Angeles). Proc. Nat. Acad. Sci. U. S. A.; 69: No. 12, 3524-5(Dec 1972).

The function $(d\sigma/dlnt)^{1/4}$ against $(t)^{1/4}$ gives rise to a scaling law for elastic scattering of elementary particles on protons, for barycentral angles from 0 to 90°, and for laboratory momenta from 5 to 25 GeV/c. (auth)

13202 STATISTICAL BOOTSTRAP MODEL. Hamer, C. J. Pasadena, CA; California Inst. of Tech. (1972). 144p. University Microfilms Order No. 72-30,800.

Thesis.

A review is presented of the statistical bootstrap model of Hagedorn and Frautschi. This model is an attempt to apply the methods of statistical mechanics in high-energy physics, while treating all hadron states (stable or unstable) on an equal footing. A statistical calculation of the resonance spectrum on this basic leads to an exponentially rising level density $\rho(m) \sim cm^{-3}\, e^{\beta_0 m}$ at high masses. Explicit formulas are given for the asymptotic dependence of the level density on quantum numbers, in various cases. Hamer and Frautschi's model for a realistic hadron spectrum is described. A statistical model for hadron reactions is then put forward, analogous to the Bohr compound nucleus model in nuclear physics, which makes use of this level density. Some general features of resonance decay are predicted. The model is applied to the process of $N\bar{N}$ annihilation at rest with overall success, and explains the high final state pion multiplicity, together with the low individual branching ratios into two-body final states, which are characteristic of the process. For more general reactions, the model needs modification to take account of correlation effects. Nevertheless it is capable of explaining the phenomenon of limited transverse momenta, and the exponential decrease in the production frequency of heavy particles with their mass, as shown by Hagedorn. Frautschi's results on "Ericson fluctuations" in hadron physics are outlined briefly. The value of β_0 required in all these applications is consistently around [120 MeV]$^{-1}$ corresponding to a "resonance volume" whose radius is very close to λ_π. The construction of a "multiperipheral cluster model" for high-energy collisions is advocated. (Diss. Abstr. Int., B)

13203 DECAY WIDTHS OF THE RESONANCES WITH ARBITRARY SPIN. Lee, C. Lafayette, IN; Purdue Univ. (1972). 64p. University Microfilms Order No. 72-30,926.

Thesis.

By analogy to the decomposition of the high spin spinor, a decomposition of the polarization tensor is proposed and proved. The above decomposition is used to derive formulas to express the decay matrix elements and decay widths of the boson resonances with arbitrary spin which decay into a pion and a boson resonance with spin 0, 1, or 2. Using the transformation matrix elements between different sets of basic state vectors, formulas are derived to express the partial-wave decay matrix elements and the partial-wave contributions to the decay width. The approximation in which the high partial-waves are ignored in the decay of baryon resonances with arbitrary spin is then compared with the usual approximation which consists only of the decay amplitude associated with the minimum number of momenta. The discrepancy between these two approximations increases as the mass and the spin of the decaying baryon increase. It amounts to 7% for the decay $\Delta(1950, \frac{7}{2}^+) \rightarrow \pi + \Delta(1236, \frac{3}{2}^+)$. However, it does not seem to be

significant compared with large experimental uncertainties in the decay widths. (Diss. Abstr. Int., B)

Strong (Baryon No. = 0)

Refer also to abstract 13082.

13204 (COO-1764-158) SPECTROSCOPIC CONSEQUENCES OF EXACT DUALITY FOR BARYONS. Rosner, J. L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1972. Contract AT(11-1)-1764. 47p. Dep. NTIS.

Those backward meson-baryon scattering and (baryon + antibaryon → two mesons) processes which are exotic in the direct channel are assumed to be dominated at high energy by the exchange of baryon trajectories whose imaginary parts cancel exactly. A solution to these constraints in accord with the lowest-lying baryon states is obtained; the residue ratios are found to vary along the trajectory. Properties of a $J^P = {}^7/_2{}^+$ baryon octet in the mass range 1950 to 2200 MeV, predicted by these constraints, are examined. For example, one expects a $J^P = {}^7/_2{}^+$ N(1950) with $\Gamma(\pi N) \simeq 13$ MeV and $\Gamma(\pi\Delta) \simeq 80$ MeV, whose effects might also be visible in $\pi N \to K\Sigma$, and a $J^P = {}^7/_2{}^+$ $\Lambda(2100)$, with $\Gamma(\Sigma\pi) \simeq 22$ MeV and $\Gamma(\Sigma[1385]\pi) \simeq 60$ MeV, whose KN coupling should be very small. A further prediction is that of a G_{39} πN resonance, $\Delta(2200, J^P = {}^9/_2{}^-)$, whose effects could be visible in backward $\pi^+ p$ scattering. (auth)

13205 (DESY-72/55) FURTHER REMARKS ABOUT THE $\epsilon(700)$ MESON AND BROKEN SCALE INVARIANCE. Renner, B.; Staunton, L. P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1972. 11p. Dep. NTIS (U. S. Sales Only).

An earlier paper is modified to remove an inconsistency in the previous approach, and a somewhat improved agreement between empirical sets of $(\pi\pi)$ phase shifts and constraints from broken scale invariance is reported. (auth)

13206 (JINR-E1-6753) $\pi\pi$-SCATTERING LENGTHS a_0 AND a_2 FROM THE ANALYSIS OF τ DECAYS. Bunyatov, S. A.; Gulkanyan, G. R.; Kurbatov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. Dep. NTIS (U. S. Sales Only).

The analysis of the experimental data on 1,500,000 $\tau^{\pm}$ decays given by Ford et al. was performed within the framework of the theory of three-particle production near the threshold. The s-wave $\pi\pi$ scattering lengths obtained from this analysis with the accuracy of the squared terms by pions relative momenta are as follows: $a_0 = \pm(0.57 \pm 0.04)\lambda_\pi$, $a_2 = \mp(0.16 \pm 0.01)\lambda_\pi$. The ratio of the scattering lengths $a_0/a_2 = -(3.6 \pm 0.3)$ is in good agreement with Weinberg's prediction $a_0/a_2 = -{}^1/_2$, but the $\pi\pi$ scattering length values are 2.5 to 3 times larger than those of $a_0 = 0.2\ \lambda_\pi$ and $a_2 = -0.06\ \lambda_\pi$ predicted by Weinberg on the basis of current algebra. (auth)

13207 GENERALIZATION OF THE CONSTRAINTS ON THE $\pi^0\pi^0$ S-WAVE DUE TO POSITIVITY AND CROSSING SYMMETRY. Kamimura, K.; Saito, S. (Tokyo Metropolitan Univ.). Nucl. Phys.; B51: 441-60(1973).

The constraints are derived on the low-energy parameters of the $\pi^0\pi^0$ s-wave amplitude $f_0(s)$ induced by crossing symmetry and positivity of imaginary parts of partial wave amplitudes, which can be extended to arbitrary-order expansion of $f_0(s)$. (auth)

13208 GAUGE THEORIES, CHIRAL INVARIANCE, AND ELECTROMAGNETIC MASS DIFFERENCES. Bardakci, K. (Cambridge Univ., Eng.). Nucl. Phys.; B51: 174-88(1973).

A spontaneously broken gauge theory of strongly interacting bosons, based on the chiral SU(2) × SU(2) group, is constructed. The model is renormalizable, and reproduces most of the well known results of hard-pion calculations or effective chiral Lagrangians. Chiral symmetry breaking can be introduced only through the fourth component of a chiral vector. The model can be enlarged to include electromagnetic interactions. The electromagnetic mass differences, even in case of broken chiral symmetry, turn out to be finite and non-arbitrary. (auth)

13209 UNITARITY CORRECTIONS TO PION-PION SCATTERING FROM CURRENT ALGEBRA. Borges, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B51: 189-204(1973).

A method is presented to unitarize the hard-pion current-algebra pion-pion amplitude derived by Schnitzer. A three-parameter crossing symmetric amplitude is obtained that does not have any arbitrary function for simulating the left-hand discontinuities. Elastic unitarity is satisfied in the lowest-order correction to current algebra. Once the P-wave is given in the low-energy region, this method leads to a sharp determination of the S-wave phase shifts. The solution favors the down type for the I = 0 S-wave phase shifts. (auth)

13210 TWO-PION EXCHANGE CONTRIBUTION TO THE NUCLEON–NUCLEON POTENTIAL. Epstein, G. N.; McKellar, B. H. J. (Univ. of Sydney). Lett. Nuovo Cim.; 5: No. 12, 807-13(18 Nov 1972).

The results of a calculation of the intermediate-range nucleon-nucleon interaction mediated by two-pion exchange are reported. The basic technique was the use of Onne's dispersion relations for the amplitudes, expressing them in terms of πN scattering data on the left-hand cut, and the $\pi\pi$ phase shifts. (L.B.S.)

13211 CALCULATION OF MESON MASSES IN A UNITARY-INVARIANT, FOUR-FERMION MODEL WITH AN INDEFINITE METRIC. Nguen Ngok Zao; Naumov, A. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 208-12(1972). (In Russian).

Meson masses and their constants associated with quarks were calculated within the framework of a unitary-invariant four-fermion model with an indefinite metric. The meson mass values obtained were in satisfactory agreement with experimental data. (tr-auth)

13212 STATISTICAL MODEL OF $\bar{p}n$-ANNIHILATION AT REST. Gridneva, S. A.; Rus'kin, V. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 30-2(1972). (In Russian).

A statistical model was used to describe a $\bar{p}n$-annihilation at rest, allowing for the conservation of P- and G-parity. Ten channels were calculated for annihilation with the formation of K-mesons, and 14 without K-meson formation. (K.S.W.)

13213 MASS EIGENVALUE PROBLEM IN A SU_2-INVARIANT PSEUDOSCALAR MESON THEORY WITH AN INDEFINITE METRIC. Marioni, C. (Univ., Milan); Montaldi, E. Nuovo Cim.; 12A: No. 4, 997-1015(21 Dec 1972).

The conventional SU_2-invariant pseudoscalar meson theory is regularized by introducing an indefinite-metric space. All quantities entering our model are finite. This fact enables us to state a mass eigenvalue problem for the π-N system in a way free from the usual troubles due to the appearance of divergences. Moreover, a relation between the renormalized coupling constant G_R and the ratio of the pion mass to the nucleon one is obtained. (auth)

13214 EXCHANGE-DEGENERATE AND EXOTIC TRAJECTORIES IN A MULTIPERIPHERAL MODEL WITH VENEZIANO-TYPE PRODUCTION AMPLITUDES. Biebl, K. J. (Institut fuer Hochenergiephysik, Berlin); Ebert, D.; Kaschluhn, F. Ann. Phys. (Leipzig); 28: No. 1, 48-52(1972).

The implications of duality and absence of exotics are investigated in a multiperipheral model of pseudoscalar meson-meson scattering. An exchange-degenerate leading trajectory is obtained besides low lying ones in exotic and nonexotic channels. (auth)

13215 EFFECTS OF THE $K\bar{K}$ THRESHOLD IN $\pi\pi$ SCATTERING. Fujii, Y.; Kato, M. (Tokyo Univ.). Nuovo Cim.; 13A: No. 1, 311-19(1 Jan 1973).

Angular distributions of pions at $W_{\pi\pi} \sim 2m_K$ in the process $\pi N \to \Delta\pi\pi$ are analyzed in terms of the $\pi\pi$ scattering amplitudes. Unitarity with respect to the $\pi\pi$ and $K\bar{K}$ channels is taken into account exactly, while possible effects of other channels are treated phenomenologically. It is concluded that the observed sharp change of the moment $\langle Y_1^0 \rangle$ and the S*(1070) peak arise either from a virtual level or a loosely bound state of the $K\bar{K}$ system, and that the $\pi\pi$ phase shift in the I = J = 0 state is most likely of the "up-down" type except for a possible sharp rise occurring immediately below the $K\bar{K}$ threshold. No nearby poles are associated with the $\epsilon(700)$. (auth)

13216 OPTIMAL SET OF CONSTRAINTS BETWEEN LOW PARTIAL-WAVE AMPLITUDES IN THE UNPHYSICAL REGION. Dita, P. (Inst. of Physics, Bucharest). Nuovo Cim.; 13A: No. 1, 172-80(1 Jan 1973).

A denumerable set of rigorous constraints between s and d waves for the $\pi^0\pi^0$ scattering is derived. The set is complete optimal and improves the results of Martin. (auth)

13217 CAN THE PION FORM FACTOR BE DETERMINED FROM PION ELECTROPRODUCTION? Kellett, B. H. (Univ. of Manchester, Eng.); Verzegnassi, C. Nuovo Cim.; 13A: No. 1, 195-209(1 Jan 1973).

The standard procedures for obtaining the pion form factor from single-pion electroproduction experiments are examined in detail. Unfortunately, the quantity that can be determined from experiment contains an unknown function of t and k^2. There is clear evidence that this unknown term cannot be neglected, and

this introduces an ambiguity into the determination of $F_\pi(k^2)$ that is not resolved by present experiments. A less ambiguous way of interpreting the data is proposed, and a kinematical region in which further experiments would be useful is suggested. (auth)

13218 ISOSPIN INVARIANCE CONSTRAINTS, FACTORIZATION, AND EXCHANGE DEGENERACY IN INCLUSIVE PROCESSES Papageorgiou, S. (CERN, Geneva). Nuovo Cim.; 13A: No. 1, 210-16(1 Jan 1973).

Isospin constraints are combined with the criterion for rapid scaling in inclusive reactions ($AB\bar{C}$ exotic), factorization, and exchange degeneracy. With these assumptions discrepancies arise for reactions like antibaryon + baryon → meson + X. Relations are derived which could distinguish, when experimentally tested, between existing criteria for rapid scaling. (auth)

13219 ANALYTICITY PROPERTIES OF FIVE-PARTICLE AMPLITUDES IN QUANTUM FIELD THEORY. Alvarez-Estrada, R. F. (CERN, Geneva). Nuovo Cim.; 13A: No. 1, 1-42(1 Jan 1973).

In a five-particle process a + b → 1 + 2 + 3, where the invariant mass of 2 and 3 is such that this pair can scatter only elastically in the final state, the conventional production amplitude T is related easily to a new amplitude T_{23-} which has simpler analyticity properties than T in relativistic quantum field theory. Concerning the physical interpretation of T_{23-}, its (l,m) partial wave can be consistently regarded as the inelastic scattering amplitude for a + b → 1 + (one composite particle with angular momentum (l,m)). It is shown that T_{23-} and its absorptive part have analyticity properties in three angular variables which generalize those of the four-particle amplitudes inside the Lehmann ellipses. The problem of deriving dispersion relations for T_{23-} is also investigated. (auth)

13220 NONLINEAR REALIZATIONS OF SU(3) x SU(3) AND THE SYMMETRY BREAKING MESON LAGRANGIAN. McDonald, A. P. Lafayette, IN; Purdue Univ. (1972). 54p. University Microfilms Order No. 72-30,935.

Thesis.

It is shown how to convert the octet of pseudoscalar mesons which transform nonlinearly under the group SU(3) × SU(3) to the linear realizations $(3,\bar{3})$ and $(\bar{3},3)$. It is then shown how to construct higher realizations of the form $(p,\bar{p})$ from these, making it possible to write down effective meson Lagrangians which break chiral SU(3) in a specific way. These Lagrangians are constructed so that the breaking is in the mass term and belongs to particular representations of SU(3) × SU(3). An attempt is made to pin down the way in which the strong interactions break SU(3) × SU(3) by comparing the experimental results with the scattering lengths predicted by these Lagrangians. In particular a scheme proposed by Kuo is examined and is found to give quite attractive results. (Diss. Abstr. Int., B)

13221 ISOSPIN ANALYSIS OF HADRONIC DIFFRACTIVE PRODUCTION. Koba, Z. (Univ. of Copenhagen). Acta Phys. Pol.; B3: No. 6, 789-804(1972).

Two important aspects of the isospin analysis of hadronic diffractive production processes are discussed. They are cross-channel isospin representation, and isospin analysis of "integrated cross sections". Examples are taken from single pion production in πN and NN collisions, and graphical illustration of the results is presented. (auth)

13222 RELATIVISTIC QUARK MODEL FOR DIFFRACTIVE EXCITATION OF MESONS. Byers, Nina (Univ. of California, Los Angeles). Acta Phys. Pol.; B3: No. 6, 889-96(1972).

The Böhm, Joos, Krammer relativistic quark model is used to obtain high energy meson scattering amplitudes from quark-quark elastic (absorptive) scattering amplitudes. A relativistic form of Glauber's multiple scattering expansion is assumed, and some results reported. (auth)

13223 LEVEL SHIFTS AND WIDTHS OF $p\bar{p}$-ATOM. Dal'karov, O. D.; Samoilov, V. M. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 249-51(20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 353-4(20 Sep 1972).

The shifts and widths of the S levels (principle quantum number n = 1 and 2) of the $p\bar{p}$ atom in different spin-isospin states are calculated by using the Bryan–Phillips potential for the nucleon-antinucleon interaction at low energies. The results show that the shift and widths of the S levels are very sensitive to the spin-isospin structure of the strong interaction at low energies. (JFP)

Strong (Baryon No. = 1)

Refer also to abstracts 12167, 13092, and 13097.

13224 (AD–743395) MESONIC STRUCTURE IN THE NUCLEON. Galloway, K. F.; Mann, A.; Weiner, R. M. (Indiana Univ., Bloomington. Dept. of Physics). 20 Jul 1971. 7p. (AROD–5992:49-P). NTIS.

The structure of the nucleon is one of the central problems of high energy physics. Recently much effort has been devoted to interpreting experimental high energy data in terms of elementary constituents of the nucleon: partons, quarks, etc.; but these efforts are handicapped by the fact that these ad hoc constituents have not been observed. However, the problem of the structure of nucleons can be approached in a different way. The picture of a mesonic cloud surrounding the nucleon has existed in the folklore of particle physics for a long time; but a precise meaning of this concept does not exist. In view this concept should be considered along lines similar to the problem of nucleons in nuclei. The essential point in this case is the assumption that mesons exist in nucleons, in the sense that the meson distribution manifests itself in scattering experiments on nucleons, in much the same way as the nucleon distribution appears in scattering on nuclei. (auth) (GRA)

13225 (COO–1764–159) RESONANCE DECAYS INVOLVING VECTOR MESONS. Petersen, W. P.; Rosner, J. L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Aug 1972. Contract AT(11-1)-1764. 11p. Dep. NTIS.

A picture of resonance decays using only very general features of the quark model is applied to the case of $\frac{1}{2}^+1^-$ final states. Recent experiments on πN → Nρ provide a crucial test of the model, which predicts correctly the dominant spin of the Nρ system in several cases. (auth)

13226 (JINR–E2-6803) πN-SCATTERING AT HIGH ENERGIES IN THE QUASIPOTENTIAL APPROACH. Dzhgarkava, M. I.; Garsevanishvili, V. R.; Goloskokov, S. V.; Kazarinov, Yu. M.; Matveev, V. A.; Potashnikova, I. K.; Silin, I. N.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 48p. Dep. NTIS (U. S. Sales Only).

Experimental data on πN-scattering in the momentum transfer region $0.01 \leq |t| \leq 1.0$ (GeV/c)^2 and $P_L \geq 10$ GeV/c are described in the framework of the quasipotential approach. The parameters of the quasipotential are found which allow the data to be described satisfactorily. (auth)

13227 (LBL–1314) Y* SEARCH. Lasinski, T. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Oct 1972. Contract W-7405-eng-48. 22p. (CONF-720954–2). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

The Y* situation in the 1600- to 1900-MeV mass region is summarized. The lower partial waves S, P_1, P_3, and D_3 are emphasized. The old and new data, methods of partial wave analyses, and the Y*(1405) are covered. (JFP)

13228 (TID-26236) PARTIAL-WAVE ANALYSIS OF THE REACTION $K^-n \to \Sigma^+\pi^-\pi^-$ FROM 1.62 TO 1.74 GeV. Capps, C. D. (Florida State Univ., Tallahassee. Coll. of Arts and Sciences). Aug 1972. Contract AT(40-1)-3509. 42p. Dep. NTIS.

Thesis.

A formalism for a partial wave analysis of the reaction 1 + 2 → a + b + c using an isobar approximation is developed and applied to the reaction $K^- + d \to \Sigma^- + 2\pi^- + p$ at 1.62 to 1.74 GeV. Two sets of fitted parameters are given. It is tentatively concluded prior to final results that the angular distribution are more sensitive than the mass distributions to values of the parameters. Also the total cross sections and mass distributions have the best fits. (JFP)

13229 EVIDENCE FOR DUALITY CONSTRAINTS IN $\Delta \to \pi^+\Delta$ (1236) DECAYS. Mehtani, U. (Univ. of California, Riverside); Fung, S. Y.; Kernan, A.; (and others). Phys. Rev. Lett.; 29: No. 24, 1634-7(11 Dec 1972).

Partial-wave analysis of $\pi^+ + p \to \pi^0 + \Delta^{++}$ at 1820 to 2090 MeV cm energy shows that this reaction is dominated by the $F_{37}(1950)$ resonance decaying to Δ(1236) with s-channel helicity $\frac{3}{2}$. The analysis also gives evidence for $F_{35}(1890) \to \pi + \Delta$ via F wave. The coupling of F_{37} to helicity-$\frac{3}{2}$ states, and the unexpected dominance of F- over P-wave decay for $F_{35}(1890)$, can both be interpreted as arising from the constraints of s-t channel duality. (auth)

13230 APPLICATION OF THE RINGLAND–ROBERTS–ROY–TRAN THANH VAN REGGEIZED ABSORPTION MODEL TO HY-

PERCHARGE-EXCHANGE REACTIONS. Barkai, D. (Imperial Coll. of Science and Tech., London); Moriarty, K. J. M. Nucl. Phys.; B50: No. 1, 354-78(1972).

The $0^-\frac{1}{2}^+ \rightarrow 0^-\frac{1}{2}^+$ hypercharge-exchange reactions: $\pi^+p \rightarrow K^+\Sigma^+$, $K^-p \rightarrow \pi^-\Sigma^+$, $K^-p \rightarrow \pi^0\Lambda$, $K^-p \rightarrow \eta\Lambda$, $K^-p \rightarrow \eta'\Lambda$, $\pi^-p \rightarrow K^0\Lambda$, $\pi^-p \rightarrow K^0\Sigma^0$, $K^-n \rightarrow \pi^-\Lambda$ and $K^-n \rightarrow \pi^-\Sigma^0$ are studied within the framework of a Reggeized absorption model recently proposed by Ringland, Roberts, Roy and Tran Thanh Van. The use of SU(3) symmetry and strong exchange degeneracy gives all the parameters for the pole graphs with the exception of the spin nonflip and spin fl... D/F ratios. The absorptive corrections are applied in the norma... manner to the rotating phase part of the pole-graph amplitude, but an additional phase of $\frac{1}{2}\pi$ is included in the absorptive correction for the nonrotating phase part of the pole-graph amplitude. The agreement between the theoretical predictions and the experimental data on differential cross sections and polarizations is extremely good. (auth)

13231 DIFFERENCE OF THE TOTAL CROSS SECTIONS AND THE RATIO OF THE DIFFERENTIAL CROSS SECTIONS OF π^+p HIGH ENERGY SCATTERING. Baluni, V. Z.; Vernov, Yu. S.; Dumbrais, O. V.; Mnatsakanova, M. N. (Moscow State Univ.). Teor. Mat. Fiz.; 13: No. 3, 362-7(Dec 1972). (In Russian).

On the basis of the general properties of the scattering amplitude and the experimental data on the total and differential cross sections of the $\pi^\pm p$ forward scattering the following formulas are obtained: $\int_{s_0\Gamma\partial\phi}^{\infty} \ln\{[d\sigma + (E,0)/dt]/[d\sigma - (E,0)/dt]\}\, dE/E = -0,112 \pm 0,025$, and $\int_{s_0\Gamma\partial\phi}^{\infty} [\sigma + (E) - \sigma - (E)/E]\, dE = -0,103 \pm 0,016$. (auth)

13232 CROSS SECTIONS FOR RESONANCE PRODUCTION IN THE REACTION $\pi^\pm p \rightarrow p\pi^\pm\pi^+\pi^-$ AT 16 GeV/c, AS OBTAINED BY A MAXIMUM LIKELIHOOD FIT. Aachen-Berlin-Bonn-CERN-Heidelberg Collaboration. Nucl. Phys.; B50: No. 1, 157-65(1972).

Cross sections for resonance production in the reactions $\pi^\pm p \rightarrow p\pi^\pm\pi^+\pi^-$ at 16 GeV/c are determined by a maximum likelihood fit, making use of the measurements of all individual events. The reactions are described by a simple parametrization based on an incoherent superposition of amplitudes for quasi two-body and quasi three-body processes and a nonresonant background. In this way the reflections are accounted for in a consistent way. Thus cross sections are obtained for Δ^{++}, Δ^0, ρ^0 and f^0 production which do not suffer from the uncertainties of background subtraction typical of the usual technique of fitting individual mass distributions. (auth)

13233 COMPARISON OF LONGITUDINAL PHASE SPACE ANALYSIS OF FOUR-, SIX-, AND EIGHT-BODY EVENTS. Aachen-Berlin-Bonn-CERN-Cracow-Dubna-Durham-Heidelberg-Nijmegen-Paris (E.P.)-Saclay-Torino-Warsaw Collaboration. Nucl. Phys.; B50: No. 1, 80-6(1972).

Six- and eight-body final states produced in $\pi^\pm p$ interactions at several energies were reduced to four-body final states by neglecting the two and four slowest pions, respectively. It was found that "pseudo-four-body" states thus obtained show similar behavior to true four-body ones. This is demonstrated by comparing the distribution of events in corresponding LPS sectors. The fraction of events falling in a given sector is a smooth function of the average cm kinetic energy per particle. The same function describes true four-body and pseudo-four-body states obtained from six- and eight-body events. This observation suggests that the emission of the slower pions is weakly correlated to the emission of the fastest particles. (auth)

13234 HOW TO OBTAIN THE CORRECT NEUTRON–PROTON MASS DIFFERENCE. Yoshii, Hiroaki (Tokyo Inst. of Tech.). Nucl. Phys.; B50: No. 1, 10-16(1972).

The inelastic contribution to the p−n mass difference as well as the elastic one was calculated by using the Cottingham formula. It is found out that, in order to get the correct sign of the p−n mass difference, the ratio of the longitudinal to transverse cross sections, $R(q^2)$, must be smaller than 2, and that $(2 - R(q^2))$ $W_1^{p-n}(\omega,q^2) \rightarrow 0$ as $q^2 \rightarrow \infty$ is required to ensure a finite p−n mass difference. Numerical calculations were carried out by assuming the appropriate forms for $R(q^2)$ and $W_1^{p-n}(\omega,q^2)$. The model in which a photon couples to a parton via a heavy vector meson is considered as an example, and one obtains the result that the mass of this vector meson may be about 150 times the nucleon mass in order to get the correct p−n mass difference 1.29 MeV. (auth)

13235 DISPERSION RELATIONS FOR THE SQUARE OF THE SCATTERING AMPLITUDE. Ferrari, E.; Violini, G. (Univ., Rome). Lett. Nuovo Cim.; 5: No. 16, 1027-96(16 Dec 1972).

The possibilities offered by nonlinear dispersion relations for the square of the scattering amplitude is investigated. A quadratic dispersion relation is obtained for forward pion–nucleon scattering as an illustrative example. (L.B.S.)

13236 INCLUSIVE POLARIZATION, TWO-PARTICLE CORRELATION AND TRIPLE-REGGEON PHENOMENOLOGY. Iso, C.; Kanasugi, H.; Miyata, Y. (Tokyo Inst. of Tech.). Nucl. Phys.; B51: 255-68(1973).

The single-particle spectrum in the inclusive reaction induced by a polarized particle, and the polarization of the final nucleon are expressed in terms of the helicity-dependent forward scattering amplitudes of three particles. These spin-dependent analyses allow us to separate some of the two-particle correlation functions kinematically. A triple Regge picture is applied to the reaction $\pi + N \rightarrow \pi(\eta) +$ anything. (auth)

13237 PARTIAL WAVE RELATIONS IN $\pi\Lambda$ SCATTERING AND THE $\Sigma\Lambda\pi$ COUPLING CONSTANT. Engels, J. (Univ., Bielefeld, Ger.). Nucl. Phys.; B51: 269-88(1973).

An investigation of relations for the $P_{\frac{3}{2}}$, $D_{\frac{3}{2}}$, and $S_{\frac{1}{2}}$ partial waves in $\pi\Lambda$ scattering leads to the value $G^2_{\Sigma\Lambda\pi}/4\pi = 12.9 \pm 0.8$. These partial wave relations are obtained from fixed-t finite-contour dispersion relations, which are also valid, if a normal dispersion relation has to be subtracted, by projection. The unknown f and ϵ Regge residues are then connected to coupling constants. As input information the Σ-resonances and estimates of the asymptotic total $\pi\Lambda$ cross section are used. A small or even zero f-trajectory coupling to the A-amplitude together with an ϵ-trajectory coupling as determined from ϵ coupling constants is well compatible with the data. The D/F ratio for the tensor meson-baryon coupling of the B-amplitude is in the range $3.3 < D/F < 4.1$. (auth)

13238 TEST OF FINITE-CONTOUR DISPERSION RELATIONS AT FIXED t IN PION–NUCLEON SCATTERING. Baacke, J. (Freie Univ., Berlin); Engels, J. Nucl. Phys.; B51: 434-40(1973).

Finite-contour dispersion relations have the well-known advantage that they require no subtractions, at the expense of requiring better information about the asymptotic behavior than the subtracted dispersion relations. To test the reliability of the method, it is applied to the $I_t = 0$ πN scattering amplitudes in the phase-shift region, using conventional Regge asymptotics. The satisfactory outcome of the test may encourage other applications which are briefly discussed. (auth)

13239 ABSORPTION MODEL FOR REGGE CUTS AND THE PHASES OF THE PION–NUCLEON SCATTERING AMPLITUDES. Collins, P. D. B.; Swetman, R. A. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 5: No. 12, 793-802(18 Nov 1972).

It was previously suggested that the way in which the absorption model has been implemented needs modification, and in particular that the problems of the strong-absorption model can be solved if the phase of the $I_t = 0$ absorbing amplitudes for πN scattering are incorporated properly. It is examined whether the inclusion of $\rho P'$ as well as ρP cuts can rectify any of the commonly used versions of the absorption model and bring their predictions in accord with experiment. Parameter fits to $I_t = 0$ and $I_t = 1$ amplitudes using various modifications of the usual absorption model are presented. The results are used to fit the data on $\pi^-p \rightarrow \pi^0n$ differential cross sections, $\pi^-p \rightarrow \pi^0n$ polarization, and π^+p and π^-p elastic polarizations. The results are summarized. (L.B.S.)

13240 POSSIBLE BOSON TRIAD AROUND 1.95 GeV. Peaslee, D. C. (Australian National Univ., Canberra). Particle Nucl.; 4: No. 2-3, 73-84(1972).

A survey measurement of $\bar{p}d$ reactions below $p_L = 1$ GeV/c can be analyzed to suggest resonances at $E_0 \approx 1925$, 1951, and 1999 MeV with respective I-spins 1, 0 and 0. This is reminiscent of the (ρ, ω, φ) triad; the assumption of constant J^P for the present triad seems satisfactory. It is concluded that $(2J + 1)$ is fairly large; the $\bar{N}N$ coupling to the boson triad appears much closer to F-type than D-type. A corresponding K* resonance should appear around 1980 MeV. (auth)

13241 DIFFRACTIVE PRODUCTIONS AND LEVEL DENSITY OF MESON RESONANCES IN THE RELATIVISTIC EXTENDED QUARK MODEL AND MISSING-MASS SPECTRA OBSERVED IN $\pi^-p \rightarrow pX^-$. Kobayashi, T.; Nakamaru, N. (Tokyo Univ. of Education). Lett. Nuovo Cim.; 5: No. 17, 1067-72(23 Dec 1972).

The sum of diffractive meson resonance productions in inclusive interactions is studied in the quark model and compared with the missing-mass spectra observed in $\pi^-p \rightarrow pX^-$ at 25 and 40 GeV/c. It is shown that the level density of resonances predicted by the quark model well reproduces the contribution of resonance production in the CERN-IHEP data. (L.B.S.)

13242 SMOOTHED VENEZIANO MODEL WITH APPLICATION TO $K^-p \to \overline{K}^{*0}n$. Collins, P. A. (Imperial Coll. of Science and Tech., London); Hartley, B. J.; Moriarty, K. J. M.; Moore, R. W. Nuovo Cim.; 13A: No. 1, 90-8(1 Jan 1973).

By means of a simple amplitude for $K^-p \to \overline{K}^{*0}n$ a test of a smoothed Veneziano model is made. (auth)

13243 ANALYSIS OF πN CHARGE-EXCHANGE SCATTERING WITH THE USE OF PHASE-SHIFT AND REGGE-POLE AMPLITUDES. Dronkers, J. (CEN, Saclay, France). Nuovo Cim.; 13A: No. 1, 217-29(1 Jan 1973).

A continuous-moment sum rule (CMSR) analysis of the reaction $\pi^-p \to \pi^0n$ is presented and a comparison is made with an independent high energy Regge model. The CMSR used is different from the conventional ones in that the expansion in Legendre polynomials of the low energy scattering amplitude is used only in the part of the t-plane where it is expected to be convergent. A diagram is presented which displays in a simple way qualitative information on the high energy amplitudes. The analysis supports a ρ,ρ' decomposition for the spin-flip amplitude $B^{(-)}$, but such a decomposition does not describe in a satisfactory way the cross-over phenomenon in the spin-nonflip amplitude $A'^{(-)}$. (auth)

13244 MESON–BARYON CHARGE-EXCHANGE PROCESSES IN COMPLEX REGGE POLE MODEL CONSISTENT WITH DUAL ABSORPTION PICTURE. Barik, N. Riverside, CA; Univ. of California (1972). 72p. University Microfilms Order No. 72-31,483.

Thesis.

The charge-exchange processes like $\pi^-p \to \pi^0n$, $\pi^-p \to \eta n$, $K^-p \to \overline{K}^0n$ and $K^+n \to K^0p$, where ρ and/or A_2 exchanges are involved are investigated within the framework of complex-pole model. Providing consistent and reasonably satisfactory answers to the essential features of these non-diffractive processes like dips, cross-over zeroes, non-zero polarization etc., a sort of amplitude analysis is made for vector and tensor exchanges with the amplitudes in the form $\gamma_+\xi_+s^{\alpha_+} + \gamma_-\xi_-s^{\alpha_-}$. The results confirm the prediction of the dual absorption model. The real part of the complex-residue function, γ_R, is found to be $\sim J_n$ with n = 0,1. The imaginary part of the residue, γ_I, for the non-flip amplitude, the the j-plane cut being strong is $\sim -\mathcal{H}_0$, the Struve function, whereas the cuts being weak for flip amplitude $\gamma_I \sim 0$. As a matter of fact the contribution of γ_I to the real or imaginary part of the amplitudes generally appears in the form of $\alpha_I\gamma_I$ which is quite small. Therefore the imaginary part of the amplitudes behave essentially as J_n consistent with dual absorptive picture. With the complex residues for the nonflip amplitude and for the flip amplitude a good quantitative fit to all the experimental data for the charge exchange processes is obtained in terms of few parameters. For the imaginary part of the trajectory function we find $\langle\alpha_I\rangle = 0.17$ and $\langle\alpha_I\rangle_{A_2} = 0.26$. The presence of nonzero α_I removes the need for any explicit ghost eliminating factors. A detailed discussion of this model is given on phenomenological grounds and compared with other models. (Diss. Abstr. Int., B)

13245 REGGE POLE EIKONAL THEORY FOR π–N $\to \rho$–N AT SMALL ANGLES. Hanlon, J. F. Medford, MA; Tufts Univ. (1971). 148p. University Microfilms Order No. 72-30,259.

Thesis.

The eikonal model for absorptive corrections to Regge pole theory is applied to $\pi N \to \rho N$ at small angles and high energy. π, ω, and A_2 exchange, with trajectories determined by the work of Arnold, Blackmon, and Goldstein on elastic and charge exchange scattering are considered. The trajectories are exchange degenerate and nonsense choosing, as required by dual resonance models. Absorption is described by elastic rescattering proceeding by Pomeranchon exchange. A flat Pomeranchon with Gaussian residue function is used. Differential cross sections and density matrix elements are fit quite well. (Diss. Abstr. Int., B)

13246 SIDEWISE ELECTROMAGNETIC FORM FACTORS OF THE NUCLEON. Hare, M. G. (Univ. of Saskatchewan, Regina). Ann. Phys. (N. Y.); 74: No. 2, 595-601(Dec 1972).

Electromagnetic form factors are evaluated for the nucleons by using the method of sidewise dispersion relations. The threshold region is assumed to dominate the results. A π meson is used in the intermediate state expansions. The results are presented graphically. (3 figures) (auth)

13247 HEURISTIC MODEL FOR MULTI-PARTICLE PRODUCTION IN π^-p INTERACTIONS. Johnson, A. D. Honolulu, HI; Univ. of Hawaii (1972). 191p. University Microfilms Order No. 72-31,055.

Thesis.

Models based upon pion-exchange and diffraction dissociation were fitted to data from reactions of the type $\pi^-p \to$ nucleon + kπ, $2 < k < 7$ at 3.9 and 11.9 GeV/c incident momentum. These models, which include resonance production, give approximately correct mass- and t-distributions, as well as transverse and longitudinal components of momentum. Partial cross sections for dominant channels were estimated, and relations between cross sections were compared with theoretical predictions. (Diss. Abstr. Int., B)

13248 PARTIAL-WAVE ANALYSIS OF DIFFRACTIVELY PRODUCED SYSTEMS. Kotanski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol.; B3: No. 6, 805-8(1972).

The Ascoli method for the partial wave analysis of the 3π system produced diffractively is discussed. The tests of the factorization assumption are proposed. It seems that the most efficient test is to compare the density matrix elements for events in various regions of the Dalitz plot. (auth)

13249 COULOMB AND MASS-DIFFERENCE CORRECTIONS TO K^-p SCATTERING. Zimmermann, H. (Univ., Zurich). Helv. Phys. Acta; 45: 1117-1126(1972).

A K-matrix formalism is presented for low energy K^-p reactions which in a nonrelativistic model includes electromagnetic mass difference effects and the effect of the Coulomb potential. In extension of the usual K-matrix treatment both inner and outer corrections are included in a first-order perturbation treatment, in the elastic as well as in the reaction channels. The new results are compared with those of the previous K-matrix treatments. (auth)

13250 PHENOMENOLOGY OF DIFFRACTIVE REACTIONS. Kane, G. L. (Rutherford Lab., Chilton, Eng.). Acta Phys. Pol.; B3: No. 6, 845-78(1972).

In these lectures diffractive production reactions are considered with very close attention to the constraints that experimental data at accelerator energies (say below 30 GeV/c) imposes on any relevant theory. Because of three "problems" I argue that most of the traditional views of diffractive production are of limited value in describing the actual data. These problems are the existence of crossovers for diffractive production, which implies contributions which change sign between processes such as $Kp \to Q^0p$ and $Kp \to \overline{Q}_0p$, or $\pi^+N \to A_1^+N$; Miettinen and Pirilä have recently pointed out that the dramatic decrease in production momentum transfer slope with increasing M^2 must be a property of the matrix element rather than induced by kinematic effects, but the traditional models for diffractive production generally have a constant slope in the matrix elements; detailed arguments concerning sizes of diffractive cross-sections as compared with nondiffractive ones. The form which a model capable of describing the data might take is indicated by constructing an example. It uses important contributions from a number of the available s-channel helicity amplitudes, with t dependences analogous to those found in conventional two-body reactions. In addition to allowing one to describe all the qualitative features of the data, the model suggests an interpretation of t-channel helicity "conservation" and shows how to predict the helicity properties of the reaction from the shape of the differential cross section. A brief discussion is given of the energy dependence of resonances and background in the diffractive mass spectrum. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 13077, 13325, 13400, 13407, and 13641.

13251 (BARC/I–159) DWIA PROGRAM FOR THE (p,2p) REACTION IN THE ENERGY REGION OF 200 TO 1000 MeV. Jain, B. K.; Shanta, R. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 11p. INIS.

The report describes the DWIA (distorted wave impulse approximation) computer program for CDC 3600 in FORTRAN for the analysis of the (p,2p) reaction in the co-planar symmetric geometry. The program uses the di-proton model for the description of the final state, WKB approximation for the incoming and outgoing distorted waves, and relativistic kinematics. This code, therefore, is suitable for calculations in the 200 to 1000 MeV region of incident proton energy. (auth)

13252 (JU-RR-71/9) QUARK CONTENT OF A PHENOMENOLOGICAL p–p POTENTIAL. Lilja, I. A. (Jyvaskyla Univ. (Finland). Dept. of Physics). Oct 1971. 13p. INIS.

The relation $N_0 = 32.8 - 7.2 \log_{10} m_q$ (m_q in MeV) is derived between the number of sub-nucleonic particles in the proton and free quark mass m_q. It follows from this constraint that in the "naive" quark model ($N_0 = 3$) m_q is about 14 GeV. (Finland)

13253 USE OF PARTIAL-WAVE REPRESENTATIONS IN THE PLANNING OF SCATTERING MEASUREMENTS. APPLI-

CATION TO 330 MeV np SCATTERING. Arndt, R. A.; Roper, L. D. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Nucl. Phys.; B50: No. 1, 285-300(1972).

The use of partial-wave representations of existing scattering data in the planning of future measurements is described. A procedure is described for determining those measurements which are within the realm of experimental feasibility and which will produce the best definition of the scattering matrix. The procedure is then applied to 330-MeV np scattering where the presently quite uncertain phase parameters are made more precise by various hypothetical measurements. (auth)

13254 ANGULAR-MOMENTUM ANALYSIS OF PIONIC NUCLEON CAPTURE. Reitan, A. (Norges Tekniske Hoegskole, Trondheim, Norway). Nucl. Phys.; B50: No. 1, 166-93(1972).

The pionic capture reaction $A(N,\pi)(A+1)$ is analyzed in terms of the Mandelstam model for pion production by two nucleons. The results are applied to the proton-capture reactions $^{12}C(p,\pi^+)^{13}C$ and $^4He(p,\pi^+)^5He$, and comparisons are made with experiments. (auth)

13255 COMMENT ON THE ISR DIFFRACTION SLOPE AND THE PROTON DIPOLE FORM FACTOR. White, J. N. J. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Phys.; B51: 23-8(1973).

Analysis of the latest ISR pp diffraction data using the Chou-Yang model with dipole form factor, $F(q^2) = (1 + q^2/\mu^2)^{-2}$, gives values of μ^2 which decrease slowly with energy and which are close to $\mu^2 = 0.71$ (GeV/c)^2, the value obtained from fits to electromagnetic form factors. (auth)

13256 UNITARITY BOUNDS ON THE ANGULAR DISTRIBUTION IN MULTIPARTICLE PRODUCTION. Divakaran, P. P.; Kugler, M.; Soffer, J. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B51: 95-108(1973).

Given the elastic amplitude an upper bound is derived on the angular distribution in multiparticle production. From knowledge of the inelastic cross section at zero degrees a lower bound on the inelastic angular distribution is also derived. The bounds are compared with data for $p + p \rightarrow p + X$ at 19.2 GeV/c. (auth)

13257 INCLUSIVE PRODUCTION FROM NUCLEAR TARGETS. Bander, M. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B51: 145-56(1973).

The inclusive production of particles from a nuclear target is investigated. The cross section for such a process is related to a three body scattering amplitude. Once this amplitude is known for a nucleon target it may be found for a nuclear one by an extension of Glauber's multiple scattering formalism. A comparison with data is presented for proton induced inclusive production from various nuclear targets. (auth)

13258 ISOSPIN ANALYSIS OF $NN \rightarrow (\Lambda K)N$ AND COMPARISON OF ISOSCALAR AND ISOVECTOR EXCHANGE IN $NN \rightarrow (YK)N$ AT 6 GeV/c. Charlesworth, J. A.; Intizar, N.; Neale, W. W.; Rushbrooke, J. G. (Cavendish Lab., Cambridge, Eng.). Nucl. Phys.; B51: 488-98(1973).

Using new data on the reaction $np \rightarrow \Lambda K^0 p$ the three independent charge channels for the basic reaction $NN \rightarrow (\Lambda K)N$ were investigated to obtain the two isospin amplitudes and their relative phase at 6 GeV/c. Isospin zero exchange accounts for about 40% of the total reaction amplitude. These amplitudes are compared with those found for $NN \rightarrow (\Sigma K)_{\frac{1}{2}}N$ at 6 GeV/c. A Deck model is shown to explain the shape of the $I = 0$ exchange part of the combined ΛK and $(\Sigma K)_{\frac{1}{2}}$ mass spectrum. Isoscalar and isovector exchanges in $NN \rightarrow (YK)N$ are compared in terms of experimental distributions in $t' = |t - t_{min}|$ and the decay angles in the YK rest frame; in particular the Treiman–Yang angle distribution is flat for both exchanges for $t' < 1$ GeV^2 or $m(YK) < 2$ GeV. (auth)

13259 TESTS OF DIFFRACTION MODELS UP TO THE ENERGIES OF ISR MACHINES, USING PROTON–PROTON ELASTIC SCATTERING. Warty, M. D. (Victoria Jubilee Technical Inst., Bombay). Nucl. Phys.; B51: 552-6(1973).

Two tests of the diffraction model, using proton–proton elastic scattering data up to ISR energies, are discussed. The first test is of the prediction that the slope of diffraction scattering divided by the velocity parameter β^2 tends to a constant as the energy goes to infinity. The second test is whether the differential cross section at $t = 0$ remains a constant. The first test comes out all right but the second test is in difficulty in the region below 30 GeV. (auth)

13260 NON-RELATIVISTIC MODEL FOR $pp/d\pi^+$ POLARIZATION. Craigie, N. S.; Koerner, J.; Stamatescu, I. O. (Univ., Heidelberg). Phys. Lett.; 42B: No. 4, 404-8(25 Dec 1972).

The large-angle region of the $pp/d\pi^+$ reaction is investigated in a one-pion-exchange model to explain the polarization and differential cross section in the region between 1.13 to 1.41 GeV/c incident proton momentum. (auth)

13261 HADRON SCATTERING AT HIGH ENERGIES AND THE QUASI-POTENTIAL APPROACH IN QUANTUM FIELD THEORY. Garsevanishvili, V. R.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 52-79 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

A review of methods and certain results for the quasi-potential approach to hadron collision processes at high energies is given. (auth)

13262 STUDY OF SINGLE PARTICLE PRODUCTION SPECTRA $pp \rightarrow cX$. Kasman, J.; Sidhu, D. P. (State Univ. of New York, Stony Brook). Particles Nucl.; 4: No. 2-3, 85-107(1972).

The shapes of invariant single particle distributions $pp \rightarrow cX$ ($c = p, \bar{p}, \pi^{\pm}, K^{\pm}$) are examined, using experimental data from 1961 to 1971 for beam momenta in the range 3 to 1500 GeV/c. A sample of spectra at 12.5 and 19.2 GeV/c plotted against scaling variables x', η', and $p_\perp^2$ is provided. Scaling predictions, kinematics, and sum rules for processes $ab \rightarrow cX$ are discussed. (auth)

13263 ELECTROMAGNETIC MASS SPLITTING EFFECT OF I = 1 MESONS ON THE TWO-NUCLEON POTENTIAL. Yalcin, C.; Akbay, A. N. (Middle East Technical Univ., Ankara). Nuovo Cim.; 13A: No. 1, 181-94(1 Jan 1973).

A general charge-dependent correction to the two-nucleon interaction due to the electromagnetic mass differences of the I = 1, scalar, pseudoscalar and vector mesons is evaluated. The LS and S_{12} terms which arise from scalar-, pseudoscalar- and vector-meson exchanges were also taken into account. An effective charge-dependent two-nucleon potential with a Yukawa radial dependence is obtained by a least-squares fit to the charge-dependent potential arising from the ρ-meson electromagnetic mass difference. The parameters which measure the derivation from charge independence in the Blin–Stoyle and Le Tourneux potential are calculated by a simple comparison. The observed discrepancies between the neutron-proton and proton-proton scattering lengths and effective ranges in the singlet S-state are examined in terms of this potential. The Coulomb and vacuum polarization potential correction to the proton-proton effective range also shows a small difference from the neutron-proton effective range. In order to obtain agreement between neutron-proton and proton-proton scattering lengths and effective ranges it is found that the electromagnetic mass difference of ρ-mesons, $\Delta\rho = \rho^+ - \rho^0$, must lie between −1.8 and −9.0 MeV for various OBEP model parameters. (auth)

13264 ABSORPTION OF MULTIPION SYSTEMS IN NUCLEI AND THE NATURE OF THE HADRONIC SHORT-RANGE INTERACTION. Bertocchi, L. (Univ., Trieste, Italy). Lett. Nuovo Cim.; 6: No. 1, 13-19(6 Jan 1973).

A part of the work by Gottfried, who using a system of coupled-channel optical-model equations gave a general formalism including finite values of the longitudinal momentum for the low absorption of a system of many pions observed experimentally in the coherent production on nuclei, is rederived using a related but different formalism based upon the use of Feynman diagrams in the interactions of high energy particles with nuclei. Emphasis is placed on the energy dependence of terms with different A behavior, in particular it is shown that in hadroproduction reactions the possible presence of volume terms at very high energy would reveal the presence of a short-range interaction. (JFP)

13265 PROTON–PROTON PHASE SHIFTS AT 970 MeV. Matsuda, M. (Hiroshima Univ.); Watari, W. Lett. Nuovo Cim.; 6: No. 1, 23-8(6 Jan 1973).

For the phase-shift analysis of elastic proton–proton scattering at 970 MeV the justification for states $^5L_J > {}^1I_6$ for the assumption of the OPE values for the real phases is examined. It is found that two kinds of solutions give central absorption in the sense of the dual absorption model and not inconsistent with the central-absorption picture for the pomeron and the enhancement at $b = 0.5(10)^{-13}$ cm. The assumption for the higher partial waves whether the amplitudes are given by the OPE or OBE is certainly influential on the solutions. Two types of previous solutions have converged to a single solution, but a new type of solution with a nearly same chi-square value appeared starting from previous work. (JFP)

13266 PARTICLE–PARTICLE ELASTIC SCATTERING AT 90^0. Muraki, Y. (Nagoya Univ., Japan). pp 1271-5 of 12th International Conference on Cosmic Rays. Vol. 4. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol. 4).

An interpretation is given for the flat angular distribution of the large angle elastic pp differential cross section. It is shown that the large angle elastic scattering arises not from the statistical nature but from the interference of the probability amplitude. A prediction is given for the neutrino-hadron elastic scattering. (auth)

13267 n-PARTICLE CROSS SECTIONS IN DIFFRACTION-PRODUCTION MODELS. Abarbanel, H. D. I. (National Accelerator Lab., Batavia, IL); Kane, G. L. Phys. Rev. Lett.; 30: No. 2, 67-71(8 Jan 1973).

It is shown how a simple t_{min} effect can significantly alter the $\sigma_n \sim 1/n^2$ rule found in most diffractive models of particle production. Data on pp, π^-p, and K^-p collisions appear consistent with $n^2\sigma_n \sim \exp(-n^4/s)$, which implies that double diffraction dissociation is the dominant feature, and $\langle n \rangle \sim \ln s$, but correlation functions rise much more slowly than in earlier treatments. Critical comments on diffractive models are given. (auth)

13268 HIGH-ENERGY COHERENT DIFFRACTIVE PRODUCTION OF MULTIBODY STATES ON NUCLEAR TARGETS. Czyz, W. (Inst. of Nuclear Physics, Krakow); Maximon, L. C. Acta Phys. Pol.; B3: No. 6, 897-902(1972).

Arguments are given that the traditional, Glauber-like model for the multiple scattering of composite objects be modified to the extent of including relativistic deformation of the wave functions. It is argued that this modified formalism is a specific realization of Van Hove's model of coherent nuclear production of multi-body states and thus is sufficient to explain the astonishingly small nucleon total cross sections that have been extracted from multi-boson production experiments. It is shown on the simple example of Lorentz-contracted oscillator wave functions that, to have Van Hove's effect present, the interaction between the components of the diffractively produced object must be of the order of magnitude of their masses. (auth)

13269 HYPERON–NUCLEON INTERACTION. Satoh, E. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 50: No. 16, 1805-9(15 Aug 1972).

The effect of the $\Lambda\Sigma$ conversion on the binding energy of a Λ particle in infinite nuclear matter is estimated by using phenomenological hyperon–nucleon potentials. All the potentials are assumed to be central and are set up to fit the low energy ΛN and ΣN scattering including the Λp resonance below the ΣN threshold. In these potentials more realistic ranges than those in recent papers are used. (auth)

13270 COHERENT NUCLEAR PRODUCTION OF MULTIBODY STATES. Gottfried, K. (CERN, Geneva). Acta Phys. Pol.; B3: No. 6, 769-88(1972).

This is a review of the theory of coherent nuclear production of multi-body states having a broad mass spectrum. Two kinds of phenomena are of central interest: the production of broad enhancements such as A_1 and Q, and inclusive spectra in very high energy hadron-nucleus collisions. The major topics discussed are: the very interesting and informative inclusive spectra that are expected to result from nuclear collisions if diffraction dissociation plays a major role in the underlying hadron–hadron collisions; a theory of coherent production that allows for strong coupling between the elastic and coherent production channels, the longitudinal momentum transfer, and changes of mass resulting from successive diffractive collisions within the nucleus; Van Hove's model for explaining the astonishingly small total cross sections that have been extracted from multi-boson production experiments, and the questions raised thereby concerning the structure of the amplitudes that describe the scattering of the produced states by a system of nucleons. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 13619.

13271 ANALYTICAL CONTINUATION OF FUNCTIONS DEFINED ON SUBGROUPS OF THE COMPLEX LORENTZ GROUP. Kolomytsev, V. I. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 13: No. 3, 321-6(Dec 1972). (In Russian).

A question about the possibility of analytical continuation of the functions defined on the subgroups of the complex Lorentz group and arising in the group-theoretical approach to the conspiracy problem of the Regge trajectories is discussed. It is shown that a real-analytic function $f(\varphi, \cos\theta, \psi)$ on the group SU(2) which is also analytic in the variable $w = \cos\theta$ in the whole complex plane can be analytically continued to the complex-analytic function on the group SL(2,C). (auth)

13272 SU(3) PROJECTION OPERATOR AS A POLYNOMIAL IN THE GENERATORS. Noz, M. E. (Indiana Univ. of Pennsylvania, Indiana, PA). Nucl. Phys.; B51: 309-16(1973).

Any problem involving the projection of a state of definite SU(3) weight onto an arbitrary irreducible representation is equivalent to a problem involving projection onto the identity representation. Simple expressions are obtained, as power series in the generators, for the operator which performs this latter projection onto the identity representation of SU(3). (auth)

13273 CLIFFORD ALGEBRAS AND REPRESENTATIONS OF COMPLEX ORTHOGONAL GROUPS. Lord, E. A. (Inst. of Mathematical Sciences, Madras). J. Math. Anal. Appl.; 40: No. 2, 509-39(Nov 1972).

The 2^ν-dimensional spinor representations of the complex orthogonal group SO(M, C) ($M = 2\nu + 2$) are discussed. By making use of the possibility of regarding the elements of the Clifford algebra $C_{2\nu}$ as sets of skewsymmetric tensors in M dimensions (rather than in 2ν dimensions as in the usual treatment) general relations are obtained for the correspondences between rank 2 spinors and sets of tensors, valid for any dimensionality. The theory of two- and four-component spinors is discussed from the point of view obtained by considering the Lorentz group with reflections as a subgroup of SO(6, C). (auth)

13274 CONFORMAL ALGEBRA IN TWO SPACE–TIME DIMENSIONS AND THE THIRRING MODEL. Ferrara, S. (CNEN, Rome); Grillo, A. F.; Gatto, R. Nuovo Cim.; 12A: No. 4, 959-68(21 Dec 1972).

The infinitesimal generators of the infinite-dimensional conformal algebra in two space-time dimensions are constructed from the stress tensor. The conformal covariance of the operator product expansion in the Thirring model is verified, but the vacuum state is found to be invariant only under the $O_{2,2}$ subalgebra of the infinite conformal algebra. (auth)

Applications (Electromagnetic and Weak)

13275 (JINR–P2-6639) ELECTROMAGNETIC INTERACTION IN SU(3) x SU(3) SYMMETRY AND PSEUDOSCALAR MESON DECAYS. Zupnik, B. M.; Ivanov, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

The electromagnetic interaction in the dynamical chiral $SU_3 \times SU_3$ symmetry is investigated by the effective Lagrangian method. It is assumed that the hadron e.m. vertices are described by the effective Lagrangian L_{em} with transformation properties of conventional e.m. interaction. These properties are manifested as the invariance of L_{em} under the group $[U_2 \times U_2]_N$ whose algebra consists of neutral $SU_3 \times SU_3$ generators (2.7). The conventional $SU_3 \times SU_3$–current algebra is usually believed to fail to describe the processes of the second order in e with pseudoscalar mesons. It is argued that the difficulties of this kind do not originate from the requirement of the $[U_2 \times U_2]_N$–invariance and can be removed in the reasonable way. The experimentally wrong mass formula by Dashen arises from using the nonderivative Lagrangian ΔL^0_{em} to describe the e.m. mass-shift of pseudoscalar mesons. The model of ΔL_{em} with two derivatives is suggested in which there are no contradictions. This model corresponds to the "current-mixing" model for the e.m. violation of SU_3 and gives the reasonable estimate (3.4) for the π^0–η transition parameter. In application to the $\eta \to 3\pi$ decay, the assumption about the $[U_2 \times U_2]_N$-symmetry of e.m. $\pi^0 \to \eta$ and $\eta \to 3\pi$ transitions leads to the satisfactory results provided the appreciable derivative $\pi\eta\pi\eta$-interaction exists (with the coupling constant $|q_2| \sim 4 \div 5$). The simplest possibilities to obtain this $\pi\eta\pi\eta$-coupling are to include the triple $\eta(549) - X^0(960) - E(1420)$ mixing (if the X^0 and E are pseudoscalars) or to insert the derivative symmetry breaking term in the effective Lagrangian of strong interaction. The assumption of the $[U_2 \times U_2]_N$-symmetry in the $\pi^0 \to \gamma\gamma$ and $\eta \to \gamma\gamma$ decays does not contradict the experiment if the η–η' mixing is taken into account consistently. The conclusion is that, at the present time, there are no sufficient reasons for giving up the constructive requirement of the $[U_2 \times U_2]_N$-symmetry of the hadron e.m. interaction at low energies. (auth)

13276 ANGULAR CORRELATION TEST OF TIME REVERSAL INVARIANCE. Holmes, M. J.; Hamilton, W. D.; Fox, R. A. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys.; A199: No. 2, 401-12 (1973).

The angular correlation between the 300 keV and 600 keV groups of γ-rays occurring in ^{192}Pt following the β-decay of ^{192}Ir was measured from a cryogenically polarized source. The source was prepared by dissolving iridium into iron and cooling to 50 mK in a ^{3}He–^{4}He dilution refrigerator. A series of measurements were made and from the observed asymmetries a phase difference of $\eta \approx (4 \pm 5) \times 10^{-3}$ was found between the electric quadrupole and magnetic dipole components of the $3^+ - 2^+$ transitions. Thus no evidence is found for electromagnetic T-violation. (auth)

13277 NON-ANALYTIC TERMS AND THE EVALUATION OF c IN THE (3,3*) + (3*,3) MODEL. Cornwell, D. T. (Univ., Hamburg). Nucl. Phys.: B51: 16-22(1973).

The parameter c of the $(3,\bar{3}) + (\bar{3},3)$ model has been evaluated in the past in various ways. Recently Li and Pagels have pointed out the presence in amplitudes of terms nonanalytic in the chiral-breaking parameter. The effects of such terms on evaluations of c are considered. (auth)

13278 SYMMETRY PRINCIPLES AND CONSTRAINTS ON DEEP INELASTIC STRUCTURE FUNCTIONS. Chaichian, M.; Pallua, S. (Univ., Hamburg). Nucl. Phys.; B51: 461-87 (1973).

It is shown that isospin invariance for hadron states and the usual SU(2) transformation properties of electromagnetic and weak currents (CVC hypothesis) impose strong restrictions on the weak structure functions in terms of the electromagnetic ones. Furthermore, a quite restrictive scheme is obtained if one adds the following assumptions: (i) Electromagnetic and weak currents are members of a SU(3) octet in the usual sense. (ii) Absence of t-channel exotics. (iii) Currents transform as nonets under U(3). It is shown that this scheme gives results which are very close to the SU(2) quark-parton light-cone models. The consequences of adding the SU(3) symmetry of hadron states are also investigated. All the statements which involve weak structure functions require as an additional assumption equality of vector and axial-vector contributions to the scattering amplitudes. (auth)

13279 CURRENT ALGEBRA AND BREAKING OF SYMMETRY IN THE INTERACTIONS OF MESONS. Wienke, B. R. Evanston, IL; Northwestern Univ. (1972). 97p. University Microfilms Order No. 72-32,612.

Thesis.

This work details a study of symmetry breaking in mesonic interactions through use of the formalism of current algebra. Octets of vector and axial vector currents are postulated along with their commutation relationships. The assumption of U(3) symmetric c-number Schwinger terms gives Weinberg's first sum rule. Additional inputs such as PCAC, PCVC, smoothness of vertex functions, and meson dominance allow systematic study of certain aspects of meson interactions in the form of mass and coupling constant sum rules, mixing angle, form factor and decay predictions. In the first part attention is focused on kaonic weak decays. Using the (V−A) theory of weak interactions and the $(3^*,3)_{\oplus}$ $(3,3^*)$ breaking model, the structures of the form factors in K_{l3} and K_{l4} decays are deduced and comparisons made with existing data. In the second part of the analysis, concerned with strong breaking, a general isospin conserving symmetry breaking interaction is introduced and its effects examined in a series of mass sum rules and subsequent mixing angle and decay predictions. Some implications of possible singlet contributions to the electromagnetic current of hadrons are also discussed. (Diss. Abstr. Int., B)

13280 ASYMMETRIES IN THE $K^{\pm} \to \pi^{\pm}\pi^{0}\gamma$ DECAYS. McWethy, D. J. Evanston, IL; Northwestern Univ. (1972). 82p. University Microfilms Order No. 72-32,513.

Thesis.

Possible asymmetries in the $K^{\pm} \to \pi^{\pm}\pi^{0}\gamma$ decays, arising from CP nonconservation, are investigated in their complete generality, and the limitations upon their observation due to experimental constraints discussed. Singling out the weak interactions as the interesting and calculable case, it is shown that within the context of the milliweak class of CP nonconserving theories, independent of the details of the decay model and of the specific theory within this class, the present experimental data on the nonconservation of CP in the $K_1^0 \to 2\pi$ decays constrain the magnitudes of the asymmetries that can be expected in the $K^{\pm} \to \pi^{\pm}\pi^{0}\gamma$ decays. In properly chosen experimentally accessible energy regions, the predicted asymmetries in the various decay spectra are numerically found to be of the order of a few percent with a maximum of approximately 20%, suggesting that milliweak CP nonconservation is observable in the weak radiative decays. (Diss. Abstr. Int., B)

13281 HOW LARGE ARE SU_3 VIOLATIONS IN HIGH-ENERGY DOUBLE MESON PHOTOPRODUCTION. Gensini, P. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 6: No. 1, 39-45(6 Jan 1973).

Simple models are proposed which justify large SU(3) violations in the photoproduction of πΔ(1236) and KΣ(1385) at high energies. These models are in terms of an SU(3) symmetry broken only in the spectrum of the exchanged Regge trajectories but not in their couplings to the external particles. A particular model is not considered, but it is described how SU(3) predictions can become largely violated in an almost SU(3) symmetric world, just with the help of naive and simple dynamical models. It is shown that some asymmetries however small can have quite sizable effects if properly enhanced. (JFP)

Applications (Strong)

Refer also to abstract 13130.

13282 (COO–1764-155) RESONANCE DECAYS INVOLVING TWO PARTIAL WAVES. Petersen, W. P. (Minnesota Univ., Minneapolis. School of Physics and Astronomy); Rosner, J. L. (California Inst. of Tech., Pasadena). Feb 1972. Contract AT-(11-1)-1764. 13p. (CALT–68-352). Dep. NTIS.

Resonance decays involving two partial waves, such as $B \to \omega\pi$, can test for basic violations of $SU(6)_W$. A formalism is presented for carrying out these tests using available data on $\pi N \to \pi\Delta(1236)$ and $K^-p \to \pi Y_1^*(1385)$. (auth)

13283 (COO–1764-156) SYMMETRIES AND NONSYMMETRIES OF THE RELATIVISTIC QUARK MODEL. Rosner, J. L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1 May 1972. Contract AT(11-1)-1764. 58p. Dep. NTIS.

The dynamical successes of the relativistic quark model are separated from those due to symmetry arguments. Particular attention is paid to the example of the $q\bar{q}$; L = 1 meson decays. A relativistically invariant coplanar form of U(3) ⊗ U(3) is found to explain all predictions of the relativistic quark model for decays within a given multiplet except the absence of spin-orbit effects and relations between differential partial waves, e.g., in $B \to \omega\pi$. The coplanar symmetry is expected to be as good as the quark model classification scheme itself. It preserves most of the better predictions of $SU(6)_W$, while avoiding some that are questionable. Some of the "good" predictions preserved are $\Gamma(A_2 \to \rho\pi)/\Gamma(A_2 \to K\bar{K}) = 6$, $(d/f)_{8(5/2^-)} \to 8(1/2^+)8(0^-) = -1/3$ and $(d/f)_{8(5/2^+)} \to 8(1/2^+)8(0^-) = 2/3$. Questionable predictions of $SU(6)_W$ avoided by the coplanar symmetry include the selection rules $A_1 \to \rho(\lambda = 0)\pi$, $B \to \omega(\lambda = 1)\pi$. A model of hadron decays which assumes them to occur via production of a $^3P_0$ $q\bar{q}$ pair is consistent with (but more specific than) the coplanar symmetry. (auth)

13284 (COO–2220-5) HIGHER SYMMETRIES AND BARYON RESONANCES. Rosner, J. L. (Institute for Advanced Study, Princeton, N. J.). [nd]. Contract AT(11-1)-2220. 17p. (CONF-720954–3). Dep. NTIS.

From 16th international conference on high energy physics; Batavia, IL (6 Sep 1972).

The calculational rules for $SU(6)_W \times O(2)_{L_z}$ are reviewed for the baryon resonance decays $A \to B + C$. (JFP)

13285 CHIRAL SYMMETRY BREAKING AND THE CABIBBO ANGLE. Dittner, P. (Imperial Coll. of Science and Tech., London); Eliezer, S.; Dondi, P. H. Nucl. Phys.; B50: No. 1, 87-92 (1972).

Following the suggestion of Oakes one considers the Cabibbo rotation in models of chiral-symmetry breaking. The $m_\pi^2 \to 0$ limit implies exact SU(2) × SU(2) symmetry only in the $(3,\bar{3}) + (\bar{3},3)$ model. Thus with other models one proceeds either from Hamiltonians (with only singlet and octet parts) giving $m_\pi^2 = 0$, or from Hamiltonians displaying exact SU(2) × SU(2) symmetry. It is shown that in the first case the results are independent of the chiral properties of the symmetry breaking and that the second method is inconsistent in the (8,8) and $(6,\bar{6}) + (\bar{6},6)$ models. (auth)

13286 $SU(6)_W$ FIT TO THE NEGATIVE PARITY BARYON DECAY RATES. Faiman, D. (CERN, Geneva); Plane, D. E. Nucl. Phys.; B50: No. 1, 379-406(1972).

A least squares fit to the experimental data on decays of negative parity baryon resonances into a pseudoscalar meson and either a $J^P = 1/2^+$ stable baryon or a $J^P = 3/2^+$ decuplet member is presented. It is found that the s-waves and d-waves are separately in good agreement with the predictions of $SU(6)_W \otimes O(2)_{L_Z}$. Predictions are given regarding several as yet unobserved decay processes, and for those which concern hitherto undetected resonances, their possible detection is discussed. (auth)

13287 SHORT-RANGE REPULSION AND BROKEN CHIRAL SYMMETRY IN LOW-ENERGY SCATTERING. Serebryakov, V. V.;

Shirkov, D. V. (Inst. of Mathematics, Novosibirsk, USSR). pp 106-45 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

The introduction of short-range repulsive "potentials" into the low energy equations for the lower partial waves makes it possible to eliminate the main difficulties of the pure elastic low energy (Pele) approximation. In principle, it is then possible to obtain solutions with short s-wave scattering lengths and broad resonances. The use of threshold conditions that follow from chiral symmetry enables one (under certain simple additional conditions) to express the main resonance scattering parameters in terms of the pion decay characteristics. Thus, on the basis of the approximation of broken chiral symmetry and unitarity dispersion equations for low-energy $\pi\pi$ and πN scattering, expressions are obtained for the masses, lifetimes, and coupling constants for p-wave resonances, it being only necessary to specify the pion and nucleon masses and lifetimes and the Fermi coupling constant. (auth)

Field Theories

General

13288 WIGNER-ECKART THEOREM AND COVARIANT OPERATORS. Klimyk, A. U. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 13: No. 3, 327-42(Dec 1972). (In Russian).

Matrix elements of the operators' invariant under the group and depending on the functions of the Schwartz space (operators such as the scalar field operators) are studied. It is proved that the matrix elements of such operators are factorized in a weak sense into the Clebsch-Gordan coefficients of the group and reduced matrix elements. (auth)

Quantum Field Theory

Refer also to abstracts 13192, 13261, and 13274.

13289 (CNRS-CPT-72-P-470) SPONTANEOUSLY BROKEN GAUGE INVARIANCE: WARD IDENTITIES, SLAVNOV IDENTITIES, GAUGE INVARIANCE. Quaranta, L.; Rouet, A.; Stora, R.; Tirapegui, E. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jul 1972. 20p. (CONF-720663-1). Dep. NTIS (U. S. Sales Only).

From Meeting on the renormalization of Yang-Mills fields and applications to particle physics; Marseilles, France (19 Jun 1972).

The perturbative renormalization of Lagrangian models involving gauge fields in which gauge invariance is spontaneously broken was studied. The tree approximation was analyzed and preliminary results on renormalization effects are given. (France)

13290 (JINR-P2-6801) CORRECTIONS TO THE LAMB SHIFT IN NONLOCAL THEORY OF WEAK INTERACTION. Malyshkin, V. G.; Namsrai, Kh.; Yumatov, A. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

The contribution of weak interactions to the Lamb shift of atomic levels of order of aG^2 is analyzed in the framework of a successive nonlocal quantum field theory. The dominating corrections due to the diagrams of the vacuum polarization are calculated. Comparison of the obtained results with experimental data allows the limits for nonlocal parameters to be established. (auth)

13291 COMBINATORICS OF GAUGE FIELDS. Hooft, G.'t; Veltman, M. (Univ., Utrecht). Nucl. Phys.; B50: No. 1, 318-53(1972).

Gauge field theories can be described by many different sets of Feynman rules, depending on the particular gauge chosen. A prescription for obtaining the Feynman rules in different gauges is given. A rigorous combinatorial proof of the independence of the S-matrix of the chosen gauge is presented. The proof is general and applied to Yang-Mills type theories as well as to gravitation. For renormalizable Yang-Mills type theories it is shown that the renormalized theory is invariant with respect to renormalized gauge transformations. (auth)

13292 COMPLETENESS OF STATES, SHADOW STATES, HEISENBERG CONDITION, AND POLES OF THE S-MATRIX. Biswas, S. N.; Pradhan, T.; Sudarshan, E. C. G. (Univ. of Texas, Austin). Nucl. Phys.; B50: No. 1, 269-84(1972).

A study of the connection between poles of the S-matrix and states of the Hamiltonian of nonrelativistic quantum mechanical systems is made with a view to elucidate the concept of shadow states which have been used by one of the authors for the elimination of divergences in quantum field theory with the aid of an indefinite metric. By specific examples it is demonstrated that there exist nonrelativistic systems for which the S-matrix has poles which correspond to shadow (redundant) states which are not needed in the completeness relation. Systems with such states do not fulfill a condition on S-matrix which was derived by Heisenberg. It is further shown that there exist phase equivalent systems in which these very poles of the S-matrix correspond to genuine bound states which are absolutely necessary to complete the set of states of the system, and these discrete states may have positive or negative norm depending on the choice of the S-matrix. (auth)

13293 GAUGE IDENTITIES IN DUAL FIELD THEORY. Nakawaki, Y.; Saito, T. (Osaka Univ.). Nucl. Phys.; B50: No. 1, 253-68(1972).

In the dual pion and fermion proposed by Neveu, Schwarz and Ramond, gauge identities involving vertex parts and also off-shell supergauge identities are found. When their models are translated into the secondary quantized field theory, one no longer can impose the gauge identities as operator ones, since they would lead to a contradiction of the second-quantization rules. One therefore requires weak forms of the gauge identities just in an analogous way to the Lorentz condition in quantum electrodynamics. It is then shown that the weak forms of the identities are consistent with the second-quantization rules and also with field equations. (auth)

13294 BOUND STATES IN QUANTUM ELECTRODYNAMICS. Roy, T. (Jadavpur Univ., Calcutta). Lett. Nuovo Cim.; 5: No. 16, 1048-53(16 Dec 1972).

The wave functions and eigenvalues of the bound states in quantum electrodynamics are investigated for the case of the electron-positron field and the electromagnetic field. (L.B.S.)

13295 QUASICLASSICAL APPROXIMATION IN QUANTUM FIELD THEORY. Arkhipov, A. A. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 13: No. 3, 343-50 (Dec 1972). (In Russian).

Quasiclassical approximation in quantum field theory is deduced on the basis of the Logunov-Tavkhelidze quasipotential equation. The inverse scattering problem is solved in this approximation. (auth)

13296 RENORMALIZATION OF A UNIFIED THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Ross, D. A.; Taylor, J. C. (Oxford Univ.). Nucl. Phys.; B51: 125-44 (1973).

The renormalization of the unified theory of weak and electromagnetic interactions due to Salam and Weinberg is studied. The infinities can be absorbed by defining bare and renormalized Lagrangians, L_B and L_R, which have the same structure and the same number of independent parameters. This is demonstrated partly by appeal to Ward identities, partly by consideration of the underlying theory without spontaneous symmetry breaking, and partly by explicit calculation to second order. Because of complications with Ward identities for non-Abelian gauge symmetries, L_B and L_R are in general invariant under gauge groups containing different parameters. Since the theory accounts for many more masses and couplings than it has independent constants, the parameters appearing in L_R are not all directly related to simply measurable physical couplings. The connection between masses and coupling constants in L_R is the same as in L_B. (auth)

13297 GAUGE FIELD THEORY AND THE CABIBBO ANGLE. De Wit, B. (Inst. for Theoretical Physics, Utrecht). Nucl. Phys.; B51: 237-54(1973).

Under the assumption that strong interactions are locally gauge invariant, whereas weak and electromagnetic interactions are governed by another local gauge group, a model is constructed that can provide an explanation for the Cabibbo angle. A possible origin for the medium strong SU(3) breaking is indicated. In this model the structure of weak and electromagnetic interactions is in agreement with the Cabibbo theory. (auth)

13298 SPECTRAL REPRESENTATION TREATMENT OF PRIMITIVE DIVERGENCES IN PERTURBATION THEORY. Nielsen, N. K. (Univ., Aarhus, Denmark). Nucl. Phys.; B51: 301-8(1973).

It is pointed out that the spectral representation of current commutators in perturbation theory used by Usyukina can be modified so that it becomes feasible to calculate retarded commutators, and that the reduction formula in the version of Hepp provides a natural regulator mechanism. As an example the lowest-order radiative corrections to the electromagnetic current in spinor electrodynamics with a small photon mass are calculated. It is demonstrated

that the reciprocal charge-renormalization constant becomes a generalized function with a logarithmic singularity in the present approach. (auth)

13299 PSEUDOSCALAR MASS AND ITS RELATIONSHIP TO CONVENTIONAL SCALAR MASS IN THE RELATIVISTIC DIRAC THEORY OF THE ELECTRON. Leiter, D.; Szamosi, G. (Univ. of Windsor, Ont.). Lett. Nuovo Cim.; 5: No. 12, 814-16(18 Nov 1972).

The following question is considered: since the energy-momentum relationship relates the square of the energy to the square of the momentum plus the square of the mass (in relativistic electron theory), why is it that the mass term in the Dirac equation is taken to be simply a scalar? For example, is it possible to add an additional pseudoscalar mass term, while still satisfying all physical requirements associated with the fact that only the square of the mass is observable? It is proved that the answer to this question is in the affirmative, and at the same time an interesting property of Dirac's equation in regard to the choice of representation of the Dirac gamma-matrices and the CPT theorem is demonstrated. (L.B.S.)

13300 NONLOCAL QUANTUM SCALAR-FIELD THEORY. Efimov, G. V. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 165-89 of Particles and Nuclei. Vol. 1, Pt. 1. /Bogolyubov, N. N. (ed.). New York; Plenum Publishing Corp. (1972).

The nonlocal theory of the quantized one-component scalar field is considered; the axioms of nonlocal quantum theory are formulated. The class of relativistically invariant generalized functions is considered which can play the role of form factors in constructing perturbation-theory series for the S-matrix. It is shown that for interaction Lagrangians of the $L_I(x) = g\varphi^n(x)$ $(n \geq 3)$ type the perturbation-theory series for the S-matrix is finite and satisfies the unitarity and macrocausality conditions in each order of perturbation theory. (auth)

13301 INFRA-RED DIVERGENCES AND ADIABATIC SWITCHING. FOURTH-ORDER VACUUM POLARIZATION. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy); Remiddi, E. Nuovo Cim.; 13A: No. 1, 99-119(1 Jan 1973).

It is shown, discussing the explicit case of further order vacuum polarization, that the adiabatic switching procedure allows a proper treatment of infrared divergences, without introducing any fictitious photon mass. The new approach suggests a method of carrying out explicitly the calculation, which does not create dishomogeneity in evaluating the contributions from two- and three-body intermediate states. (auth)

13302 CONFORMAL COVARIANT WIGHTMAN FUNCTIONS. Nobili, R. (Univ., Padua). Nuovo Cim.; 13A: No. 1, 129-43 (1 Jan 1973).

A method to build covariant Wightman functions is given. Complications due to the breaking of causality are discussed. After giving a convenient definition of co-ordinate inversion to avoid the appearance of antilinear transformations, the representations of the inversion operator for various fields are given. Finally simple rules are given to build conformal covariant Wightman functions. (auth)

13303 ISOSPIN-VARIANT STATE FUNCTIONAL FOR THE YANG–MILLS FIELD. Uzes, C. A. (Univ. of Georgia, Athens). Nuovo Cim.; 13A: No. 1, 230-4(1 Jan 1973).

The gauge-covariant decomposition of the gauge potentials into their transverse and longitudinal parts is used to construct an isospin-variant "good" state functional for the non-Abelian gauge field. (auth)

13304 CHOICE OF THE ZERO-ORDER OPERATOR IN PERTURBATION THEORY. Hoffmann-Ostenhof, Th.; Mark, F. (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger.). Chem. Phys. Lett.; 17: No. 2, 303-5(15 Nov 1972).

Given a basis, the matrix representation of a hermitian operator $O = O^{(0)} + O^{(1)}$ is partitioned $O = O^{(0)\prime} + O^{(1)\prime}$ such that $O^{(0)}$ and $O^{(0)\prime}$ have the same eigenvectors and the euclidean norm of $O^{(1)\prime}$ is a minimum. This splitting corresponds to the so-called Epstein–Nesbet partition in perturbation theory. (auth)

13305 HIGH-ENERGY SUMMATION OF LADDER DIAGRAMS IN NONPOLYNOMIAL FIELD THEORIES. Horvath, Z.; Pocsik, G. (Eoetvoes Lorand Univ., Budapest). Ann. Phys. (N. Y.); 74: No. 2, 555-66(Dec 1972).

The leading high-energy behavior of the sum of ladder diagrams is discussed in local and nonlocal field theories of nonpolynomial type. It is shown that the complete amplitude satisfies an integral equation of Volterra type at high-energy and, in several cases, it possesses Regge-behaved upper bounds. This high-energy behavior is confirmed also by model calculations. (auth)

13306 PROPAGATION OF INTERACTING FIELDS. Shamaly, A.; Capri, A. Z. (Univ. of Alberta, Edmonton). Ann. Phys. (N. Y.); 74: No. 2, 503-23(Dec 1972).

The spin-one theory of Takahashi and Palmer (Phys. Rev., D; 1: 2974(1970)) leads to acausal propagation when minimally coupled to an electromagnetic field. The addition of an anomalous magnetic moment (Pauli term) allows one to recover causal propagation. In the case of the Rarita–Schwinger spin-$^3/_2$ theory it is impossible to obtain causal propagation even when all possible Pauli terms are included. Coupling of a massive spin-$^1/_2$ and massive spin-1 theory leads to causal propagation for all nonderivative vector and tensor couplings, pseudoscalar and pseudovector couplings. (auth)

13307 KALIBROVOCHNYE POLYA. (Calibration Fields). Konopleva, N. P.; Popov, V. N. Moscow; Atomizdat (1972). 240p.

This work deals with a variety of mathematical problems associated with the theory of elementary particle interaction as based on the concept of a calibration field. The latter concept embraces both strong/weak and electromagnetic/gravitational interactions of elementary particles. This unified approach to the variety of interactions permits a fresh look at former searches for a unified description of electromagnetic and gravitational fields and at Einstein's general theory of relativity. Lesser topics of importance include quantum theory of calibration fields, quantum electrodynamics, the Yang–Mills field (1954), E. Noether's theorems (1959), and the concept of phase space. (101 references) (KSW)

Gravitation and General Relativity

Refer also to abstracts 12792, 12935, 13151, and 13219.

13308 SINGLE-GRAVITON ANNIHILATION OF AN ELECTRON-POSITRON PAIR IN AN EXTERNAL ELECTROMAGNETIC FIELD. Dobrev, V. K. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 2, 184-9(1972). (In Russian).

The differential and total cross sections were calculated for a single-graviton annihilation of an electron-positron pair in electrostatic, magnetic-dipole, and magnetostatic fields. The cross sections were studied as functions of the angle and of the momentum of the positron. (tr-auth)

13309 MOTION OF PARTICLES ENTERING A SCHWARZSCHILD FIELD. Cavalleri, G. (CISE, Milan); Spinelli, G. Lett. Nuovo Cim.; 6: No. 1, 5-8(6 Jan 1973).

The semi-renormalized, renormalized, and unrenormalized velocities of a test particle in a Schwarzschild field are discussed. It is noted that above the transition velocity the test particle slows down as it approaches the source of the field. The semi-renormalized velocity of particles starting at infinity increases reaching a maximum value after which it decreases reaching zero at the Schwarzschild radius. The renormalized velocity always increases toward unity approaching the Schwarzschild radius. (JFP)

13310 NEWTONIAN ANALOGUE OF FORCE IN KERR METRIC. Singh, K. P.; Upadhyay, R. C. (Banaras Hindu Univ., India). Indian J. Phys.; 46: No. 4, 172-6(Apr 1972).

The Newtonian analog of force in the gravitational field due to a rotating sphere is considered. In the absence of rotation the force reduces to that in the Schwarzschild exterior field, which to the first order is proportional to the Newtonian force. In the presence of rotation the relativistic corrections are obtained. (auth)

Scattering Theory

Refer also to abstracts 13004, 13196, 13271, 13291, 13292, 13295, 13653, and 13934.

13311 (AAEC/TM-604) MEATPI AND SORCE: TWO PROGRAMS TO CALCULATE SCATTERING POTENTIALS FROM PHASE SHIFTS. Clayton, E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1972. 15p. Dep. NTIS (U. S. Sales Only).

A description is given of the computer programs MEATPI and SORCE which calculate an effective two body potential. Reaction matrix parameters are calculated in MEATPI from the input phase shifts, and SORCE then uses these parameters to generate the potential. (auth)

13312 (JINR-E4-6688) SYSTEMATICAL AND PRACTICAL TREATMENT OF THE FEW-BODY PROBLEM. Alt, E. O.; Grassberger, P.; Sandhas, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 20p. Dep. NTIS (U. S. Sales Only).

A systematical treatment of the n-body problem is obtained by applying (n-2) times the 3-body Faddeev technique. Since in every step the same procedure is used, this approach is algebraically transparent and yields in a natural way integral equations with kernels represented by all subsystem transition operators. The closely related Faddeev–Yakubovsky kernel shows these structures less explicitly. Applying the quasiparticle method to the approach a previously given formalism is directly reproduced which, therefore, can also be understood on the basis of the Faddeev–Yakubovsky theory. Recent attempts to introduce separable terms into this theory are contained in the previous formulation. (auth)

13313 (JINR–P2-6828) FINITE-DIFFERENCE PHASE EQUATIONS IN RELATIVISTIC THEORY OF QUASIPOTENTIAL SCATTERING. Babikov, V. V.; Grusha, G. V.; Mir-Kasimov, R. M.; Shul'gina, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 36p. (In Russian). Dep. NTIS (U. S. Sales Only).

The phase function method is generalized for the case of interaction of two relativistic particles in the framework of finite-difference formalism of quasipotential scattering theory. (auth)

13314 (JINR–P2-6829) APPROXIMATE METHODS FOR SOLUTION OF RELATIVISTIC PHASE EQUATIONS. Babikov, V. V.; Grusha, G. V.; Mir-Kasimov, R. M.; Shul'gina, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

Relativistic phase equations are used for obtaining difference equations for the scattering length and the effective radius. Some cases are considered when such equations are exactly soluble. The successive method is suggested for calculation of relativistic corrections and the perturbation theory is developed. (auth)

13315 REPRESENTATION OF PARTIAL WAVE AMPLITUDES BY POWER MOMENTS AND ITS CONSEQUENCES. I. Yatsun, V. A. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 13: No. 3, 351-61(Dec 1972). (In Russian).

The representation of partial-wave amplitudes given by the Froissart–Gribov formula in the form of the power moments is derived. Some constraints on the partial-wave amplitudes are obtained on the basis of such representation. (auth)

13316 TAKING INTO ACCOUNT ALL SCATTERING CHANNELS IN THE N-BODY PROBLEM WITH COULOMB INTERACTION. Sakhnovich, L. A. (Odessa Electrical Engineering Inst. of Communications). Teor. Mat. Fiz.; 13: No. 3, 421-7 (Dec 1972). (In Russian).

Generalized wave operators and scattering operator are constructed for the quantum N-body problem J. D. Dollard in an analogous problem takes into account only the principal channel of scattering. The possibility of the bound states of several particles is taken into account. (auth)

13317 ANALYTIC CONTINUATION OF DUAL AMPLITUDES WITH MANDELSTAM ANALYTICITY. Bugrii, A. I.; Enkovskii, L. L.; Kobylinskii, N. A.; Shelest, V. P. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 13: No. 3, 313-20(Dec 1972). (In Russian).

An analytic continuation of a dual amplitude with Mandelstam analyticity to the domain of positive s is given. The pole structure of the amplitude and its asymptotic behavior is investigated. (auth)

13318 ANALYTIC AND ALGEBRAIC STRUCTURE OF TRIPLE-REGGE AMPLITUDES. Iwasaki, Y. (Kyoto Univ.); Yazaki, S. Nucl. Phys.; B51: 628-44(1973).

The analytic and algebraic structure of the triple-Regge amplitude which is related to the single-particle distribution function near the phase-space boundary is examined in detail. This amplitude possesses interesting properties which the four-point amplitude does not. There are four cuts in the v-plane, branch points of which depend linearly on s_1. The phase of the signature factor depends crucially on which Riemann sheet is chosen. In the case $\alpha = 1$ (at $t = 0$), the triple-Regge amplitude, T, disappears only on a Riemann sheet which is non-physical, while the single-Regge amplitude, S, remains. The existence of both T and S are intimately connected with the existence of several ways of making a partial wave expansion. The amplitude T can be naturally understood as resulting from one way of performing the summation, while the amplitude S is understood as resulting from some other ways. The effect of fixed poles is discussed briefly. (auth)

13319 PION–PION SCATTERING IN A MODEL BASED ON CURRENT ALGEBRA, ANALYTICITY, AND UNITARITY. Prasad, S. C. Amherst, MA; Univ. of Massachusetts (1972). 66p. University Microfilms Order No. 72-33,012.

Thesis.

Using SU(2) × SU(2) current algebra and pion-pole dominance, an exacting crossing symmetric expression for the $\pi\pi$ scattering amplitude is derived from the Ward identities. Approximations are made which are suitable at low energy for those three- and four-point functions of the problem which cannot be determined from the constraints of current algebra. These functions are parametrized in terms of propagators and polynomials exhibiting the correct analyticity properties. Form factors, analytic in the cut plane, are expressed in effective-range form, and the s- and p-wave amplitudes are constructed in terms of them. The existence of resonances in the $\pi\pi$ system is not assumed, and soft-pion estimates are not used. Instead all the parameters are free to be varied. All the free parameters of the problem are determined self-consistently by imposing the constraints that follow from elastic unitarity. The scheme predicts all the features of low energy $\pi\pi$ scattering, the only input parameters being m_π and F_π, the pion mass and decay constant. Among the principal results are the s- and p-wave scattering lengths, the corresponding phase shifts and the determination of an important parameter which measures the isospin T = 2 component of the sigma commutator, σ^{ab}. It is found that unitarity prefers the T = 2 component of σ^{ab} to be small relative to the T = 0 component. As a consequence our scattering lengths are in excellent agreement with those obtained by Weinberg. The T = J = 1 phase shift exhibits a ρ resonance around 915 MeV with a width of 210 MeV. The T = 2, J = 0 phase shift is small and in agreement with experimental results. The T = J = 0 phase shift displays acceptable behavior at low energy; physical arguments are offered to say that its higher energy behavior is less reliable than that of the p-wave at the same energies. The results are discussed and the predictive power of the method presented is analyzed. Finally, some improvements on the calculations are suggested, including possible applications to related problems. (Diss. Abstr. Int., B)

13320 PIECEWISE ANALYTICITY OF S-MATRIX ELEMENTS AND NONLOCAL INTERACTIONS. Baumann, K.; Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 12A: No. 4, 969-89(21 Dec 1972).

In local quantum field theories ultraviolet divergences may be avoided by admitting an indefinite metric in the quantum-mechanical state space. The occurrence of negative-norm and zero-norm states (ghost states) in general leads to a violation of the unitarity of the physical S-matrix. In order to unitarize the theory in the physical subspace an appropriate procedure has to be employed which leads to the suppression of unphysical channels and as a consequence produces nonanalytic points at the thresholds of these channels which destroy the global analyticity of the S-matrix in the s-plane. If these nonanalytic points occur in the physical region they simulate nonlocal interactions which decrease with a certain power of the distance. The nonlocal effects are strongest if an S-wave 2-particle ghost channel is suppressed and are less aggravating if they involve ghost channels with higher angular momentum and a larger number of particles. (auth)

13321 REGGE CUTS AND THE EIKONAL APPROXIMATION IN FIELD THEORY. III. THE ROLE OF THE MANDELSTAM DIAGRAM. Nicoletopoulos, P.; Prevost, M. A. L. (Univ. Libre, Brussels). Nuovo Cim.; 13A: No. 1, 43-58(1 Jan 1973).

Using previous methods, the high energy behavior of the reggeon-particle Mandelstam graph is analyzed. It is shown that when only the leading term is retained in each order, this diagram yields the correct eikonal expression. The latter does not, however, stem from the neighborhood of "eikonal paths." To associate the eikonal formula with the physical picture of reggeon-particle exchange between two on-shell particles (the eikonal paths), one must necessarily consider a larger class of graphs and sum unitarity cuts instead of diagrams. Only when all the nonleading terms are retained does the Mandelstam graph gain a privileged role in producing the reggeon-particle cut. In this case both the "eikonal path" idea and the eikonal approximation fail. (auth)

13322 TWO POMERANCHUK POLES. Swiecki, M. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 13A: No. 1, 120-8 (1 Jan 1973).

The problem of the multiperipheral bootstrap of the intercept-one pomeron pole is considered. The physical implications and the possibilities for the pomeron structure are discussed. (auth)

13323 SCATTERING WITHOUT SCATTERING OPERATOR. Ekstein, H. (Argonne National Lab., IL). Ann. Phys. (N. Y.); 74: No. 2, 303-13(Dec 1972).

For potential scattering with long-range forces and for scattering with creation of massless particles, no S matrix can be properly defined. It is necessary to return to prime principles to

establish the theoretical counterpart of the observed scattering probabilities. An interpretative principle is proposed that leads to the following statement: Given a ray representation of the Poincaré group isomorphic to the Fock space representation of massive noninteracting particles, with a one-particle subspace, H^1, of irreducible representation spaces, H^1_i, and a net of local subalgebras, scattering raises the problem of finding a map $P \rightarrow \tilde{n}(P)$ from projections, P, in H^1 to quasi-number operators, $\tilde{n}(P)$, with the properties that $\tilde{n}$ is self-adjoint, the restriction of $\tilde{n}(P)$ to H^1 is P, and it annuls the vacuum Ψ_0, $\tilde{n}(P_1) + \tilde{n}(P_2) = \tilde{n}(P_1 + P_2)$ if $P_1P_2 = 0$, and the bounded functions of $\tilde{n}(P)$ are quasi-local if $\mathrm{Tr}\, P < \infty$; and from this map to show that the strong limits for spectral projections $E[\tilde{n}_i(\Delta k)]$ of quasi-number operators of particles of type i and momenta in the interval Δk exist and commute with each other. These limits are related simply to probabilities of scattering events. (auth)

13324 TOPICS IN HIGH ENERGY PHYSICS: APPROXIMATIONS IN MULTIPLE SCATTERING THEORY AND MAGNETIC MONOPOLE PRODUCTION. Newmeyer, J. L. Charlottesville, VA; Univ. of Virginia (1972). 136p. University Microfilms Order No. 72-23,437.

Thesis.

This thesis consists of two independent parts, the first on the subject of multiple scattering (Glauber) theory, and the second on the development and application of a simple model to describe the production of magnetic monopoles and other hypothetical superstrongly interacting particles. I. Multiple Scattering Theory: The optical limit of the Glauber multiple scattering theory was investigated by comparing this limit with the results of explicit calculations in the theory, and it is shown that to very small A, the optical limit results are virtually indistinguishable from the exact ones. The sensitivity of the theory to different choices of nuclear densities was also investigated, and it is found that for small-angle coherent scattering, the theory is relatively insensitive to this choice, but that for incoherent scattering and production the dependence is somewhat greater. II. Production of Superstrongly Interacting Particles: When particles like quarks and magnetic monopoles are produced in pairs, there is a suppression of the production due to the superstrong attractive forces which exist between the constituents of the pair. An approximate way of incorporating this effect into a production model is presented, and lower bounds on the masses of the particles are estimated from present experimental data using the method in conjunction with the standard statistical model. Since it turns out that the monopole and antimonopole succeed only extremely rarely in escaping each other, it is very difficult to search for them directly. Speculations are made on the feasibility of various techniques which could be used to infer the existence of monopoles indirectly. The problem of production of magnetic monopoles from internal photons is also considered. (Diss. Abstr. Int., B)

13325 MULTIPLE SCATTERING WITH A LINEARIZED PROPAGATOR. Kujawski, E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Ann. Phys. (N. Y.); 74: No. 2, 567-94(Dec 1972).

Scattering by a many-body system is studied within the framework of the "fixed scatterer" approximation and the eikonal approximation formulated in terms of a linearized propagator. If properly treated, the "fixed scatterer" approximation is able to take into account the center-of-mass motion. Specifically, the linearized propagator proposed by Abarbanel and Itzykson is studied. Although for potential scattering the above approximation is essentially equivalent to the Glauber eikonal approximation, its physical implications are quite different when applied to scattering by a composite system. The multiple-scattering series can generally no longer be simply expressed in terms of the individual on-shell scattering amplitudes, and the additivity of phase shifts is shown to break down for overlapping potentials. The implications for phenomenological calculations are discussed. Finally, the above approximation is explicitly applied to high-energy elastic nucleon–deuteron scattering, and the results are compared with several variants of the Glauber multiple-scattering formalism. (2 figures) (auth)

13326 NUMERICAL STUDY OF A MODEL THREE-BODY SYSTEM. Dodd, L. R. (Univ. of Adelaide). Aust. J. Phys.; 25: No. 5, 507-21(Oct 1972).

An investigation is made of the properties of a simple three-body system consisting of three particles moving in one dimension and interacting through δ-function potentials. The exact equations of three-particle scattering theory for this system are reduced without approximation to a set of three coupled one-dimensional integral equations which are solved numerically for a wide range of different potential strengths and particle masses. For the special case of identical particles the numerical solutions are compared with the exact solutions found previously. The method of solution for general values of the parameters, which is based on computing the eigenvalues trajectories of the kernel of the scattering equations, allows a systematic search for three-body bound states. In the case of nuclear or atomic-like configurations, a unique symmetric bound state is found and its binding energy computed. For molecular configurations, where there are two identical heavy particles interacting by the exchange of a third light particle, several excited states of both positive and negative parity are found and a comparison is made of their binding energies with the predictions of the adiabatic approximation. A reaction matrix formulation of the exact equations is used to calculate the probabilities of elastic and rearrangement scattering below the threshold for breakup. When the particles are identical, there is no elastic or rearrangement scattering in the backward direction. However, for particles of different mass or potentials of unequal strength, all kinematically possible scattering processes occur and the scattering properties of the model are quite complex. In particular an interesting feature of the calculations is the appearance of cusps in the elastic cross sections at the rearrangement threshold. (auth)

13327 COMMENT ON THE DIRECT-MATRIX SOLUTION OF A SINGULAR LIPPMANN-SCHWINGER EQUATION. Heller, E. J. (Harvard Univ., Cambridge, MA); Reinhardt, W. P. Phys. Rev., A; 7: No. 1, 365-367(Jan 1973).

A discussion of the numerical performance of singular integrals appearing in the Fredholm series leads to a procedure for obtaining the Fredholm determinant over a continuous range of energies using a single fixed quadrature mesh. The same analysis shows that the singular momentum-space Lippmann–Schwinger equation may be inverted by direct-matrix methods with no error arising from the singularity. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

Refer also to abstract 12785.

13328 (COO–1569-89) OBSERVATIONS OF THE SUPERFLUID CIRCULATION AROUND A WIRE IN A ROTATING VESSEL CONTAINING LIQUID He-II. Kral, S. F.; Zimmermann, W. Jr. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1968. 10p. (CONF-720833-22). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Observations of the superfluid circulation around a fine wire stretched along the axis of a cylindrical container filled with liquid He-II were extended to the case of the wire and container in rotation. Measurements were made of the circulation in rotation at angular velocities up to 4 rad sec^{-1} in magnitude at temperatures between 1.2 and 1.4°K. (M.H.R.)

13329 DIFFUSION-LIMITED DESTRUCTION OF METASTABLE STATES IN He II. Hereford, F. L. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 29: No. 26, 1722-5(25 Dec 1972).

The variation with temperature of the destruction rate of metastable states in He-II is accounted for in terms of their roton-limited diffusion. Rough estimates of the reaction distance at which collision-induced destruction occurs are consistent with a "bubble" model for the metastable systems. (auth)

13330 DYNAMICAL BEHAVIOR OF ^{3}He -^{4}He MIXTURES NEAR THE TRICRITICAL POINT. Kawasaki, K.; Gunton, J. D. (Temple Univ., Philadelphia). Phys. Rev. Lett.; 29: No. 25, 1661-4(18 Dec 1972).

The dynamical behavior of the normal fluid phase of liquid ^{3}He–^{4}He mixtures near the tricritical point is studied. The superfluid order parameter and the entropy fluctuation are shown to have a common characteristic frequency which is the same as that predicted by dynamical scaling for the characteristic frequency of second sound in the ordered phase. The concentration fluctuation is shown to have a smaller characteristic frequency. The critical anomalies of the transport coefficients also are determined. (auth)

13331 λ TRANSITION OF DILUTE ^{3}He IN ^{4}He SOLUTIONS. Chang, D. R. (Univ. of North Carolina, Chapel Hill). J. Low Temp. Phys.; 9: No. 5-6, 545-50(Dec 1972).

Based on an empirically extended Landau roton formula and on the fact that ^{3}He atoms participate in the movement of the normal component of liquid ^{4}He, the variation of the λ temperature with ^{3}He concentration is obtained at the saturated vapor pressure. The results are in good agreement with experiment. The present approach can also be applied to higher pressures. (auth)

13332 SPECIFIC HEAT AND SUPERFLUID DENSITY OF LIQUID HELIUM IN POROUS MEDIA. Scott, S. A.; Guyon, E.; Rudnick, I. (Univ. of California, Los Angeles). J. Low Temp. Phys.; 9: No. 5-6, 388-407(Dec 1972).

An experimental and theoretical investigation of liquid helium confined to the small pores of highly compressed powders was carried out in order to investigate size effects in liquid helium. The specific heat measurements show that the bulk specific heat singularity is replaced by a flattened peak that is shifted towards lower temperatures with decreasing pore size. The superflow onset temperature and the superfluid fraction ρ_s/ρ were determined from fourth-sound measurements in the same powders in which specific heat measurements were made. The onset temperature and the temperature of the specific heat peak were found to be equal within experimental error. The Ginzburg–Pitaevskii model was used to calculate the specific heat of liquid helium in finite systems. (auth)

13333 INTERACTION BETWEEN RADIATION AND A SUPERFLUID LIQUID SURFACE. Bozhkov, A. I. (Lebedev Inst. of Physics, Moscow). J. Low Temp. Phys.; 9: No. 5-6, 409-14 (Dec 1972).

The surface motion of a superfluid liquid due to ponderomotive effect of radiation on matter is discussed. In particular, the possibility of optical excitation of surface (capillary) waves in a superfluid liquid (He II) is considered. Using certain conditions this effect is shown to cause instability of surface waves, i.e., stimulated surface scattering of light in a superfluid liquid. (auth)

13334 ANOMALOUS ATTENUATION OF THIRD SOUND. Wang, T. G.; Rudnick I. (Univ. of California, Los Angeles). J. Low Temp. Phys.; 9: No. 5-6, 425-33(Dec 1972).

Experimental measurements of anomalously high third-sound attenuation coefficients in He II are reported. This and the onset of superflow in He-II films are associated with a macroscopic quantum uncertainty principle. (auth)

13335 INTERATOMIC POTENTIAL IN LIQUID ^{4}He. II. FOURIER TRANSFORM OF THE POTENTIAL. Sposito, G.; Hukoveh, E. (Sonoma State Coll., Rohnert Park, CA). J. Low Temp. Phys.; 9: No. 5-6, 495-8(Dec 1972).

The Fourier coefficients of a recently proposed interatomic potential for liquid ^{4}He are presented. As motivation for calculating these data, evidence for the physical validity of the new potential is discussed, and a likely role in the development of current microscopic theories of superfluidity is suggested. (auth)

13336 TEORIYA SVERKHTEKUCHESTI. (Theory of Superfluidity). Khalatnikov, I. M. Moscow; Izdatel'stvo Nauka Fiziko-Matematicheskoi Literatury (1971). 320p.

This monograph treats the contemporary status of the theory of superfluidity. The form of the spectrum of elementary excitations in superfluid helium is examined as basic to the theory. Two-component hydrodynamic equations are used to examine the propagation of sound and shock waves in superconducting liquids. The theory of kinetic phenomena in helium II, the hydrodynamics of rotating superfluid liquids, and the theory of solutions of foreign matter in helium are considered. The theories of Fermi liquids and Fermi–Bose systems are closely associated with superfluidity theory. The dispersion and absorption of sound, heat exchange with a solid body, and the motion of electrical charges are described as they relate to liquid helium. (KSW)

Superconductivity

Refer also to abstract 12473.

13337 (COO–3151-11) FAR INFRARED MEASUREMENT OF THE ENERGY GAP OF V_3Si. Report 1880. Tanner, D. B.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Sep 1972. 13p. Dep. NTIS.

The difference between the surface impedances of normal and superconducting V_3Si was measured in the far infrared (2–70 cm^{-1}) at various temperatures. The radiation was transmitted through a non-resonant cavity containing several single crystal slabs of V_3Si using a lamellar grating interferometer in conjunction with a ^{3}He cooled bolometer detector. A vacuum window isolated the detector from the non-resonant cavity. Temperature dependence measurements were made up to 30°K and no change in the surface impedance was observed near the martensitic phase transition at 21°K. The energy gap was found to be extremely anisotropic, extending, at 4.2°K, from 12 cm^{-1} ($2\Delta = 1.0\ kT_c$) to 46 cm^{-1} ($2\Delta = 3.8\ kT_c$). (auth)

13338 (N–72-26433) ULTRASONIC INVESTIGATION OF THE SUPERCONDUCTING PROPERTIES OF THE Nb–Mo SYSTEM. Lacy, L. L. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Jun 1972. 54p. (NASA-TN-D-6828). NTIS.

The superconducting properties of single crystals of Nb and two alloys of Nb with Mo were investigated by ultrasonic techniques. The results of measurements of the ultrasonic attenuation and velocities as a function of temperature, Mo composition, crystallographic direction, and ultrasonic frequency are reported. The attenuation and small velocity changes associated with the superconductivity of the samples are shown to be dependent on the sample resistivity ratio which varied from 4.3 for Nb-9% Mo to 6500 for pure Nb. The ultrasonic attenuation data are analyzed in terms of the superconducting energy gap term of the BCS theory. A new model is proposed for the analysis of ultrasonic attenuation in pure superconductors with two partially decoupled energy bands. To analyze the attenuation in pure superconducting Nb, the existence of two energy gaps was assumed to be associated with the two partially decoupled energy bands. One of the gaps was found to have the normal BCS value of 3.4 and the other gap was found to have the anomalously large value of 10. No experimental evidence was found to suggest that the second energy gap had a different transition temperature. The interpretation of the results for the Nb–Mo alloys is shown to be complicated by the possible existence of a second superconducting phase in Nb–Mo alloys with a transition temperature of 0.35 of the transition temperature of the first phase. The elastic constants of Nb and Nb–Mo alloys are shown to be approximately independent of Mo composition to

nine atomic percent Mo. These results do not agree with the current microscopic theory of transition temperature for the transition elements. (auth)

13339 ANALYSIS OF JOSEPHSON-JUNCTION INTERFEROMETERS. Stuehm, D. L. Fort Collins, CO; Colorado State Univ. (1972). 124p. University Microfilms Order No. 72-31,345.

Thesis.

The development of a quantitative method of analyzing Josephson junction interferometers is presented that includes all of the interferometer parameters. Specifically, the two and three junction symmetrical and asymmetrical current feed interferometers are numerically analyzed. The magnetic field characteristics of these interferometers are then related to the length of the Josephson junctions compared to the Josephson penetration depth, the width of the junctions and the area of the interference loop. Interferometers with junction lengths of up to $0.7\lambda_j$ and interference loop areas of up to $160\lambda_j d_i$ are presented. The determination is made that the interference and diffraction patterns of an interferometer can be obtained from the physical dimensions of the interferometer. The interference pattern flux period is shown to be dimensionally dependent and is less than the previously predicted flux quantum hc/2e. The amplitude of the interference pattern is found to depend uniquely on the dimensions and specific geometry of the interferometer rather than on its lumped characterization. The magnetic field sensitivity of the interferometer is enhanced by increasing the number of junctions in the interferometer. The symmetrical and asymmetrical current feed interferometers are each shown to have specific capabilities for making magnetic field measurements. (TSS) (Diss. Abstr. Int., B)

13340 PROXIMITY EFFECT IN THE THIN-SUPERCONDUCTOR LIMIT. Todd, R. J.; Chen, J. T.; Kim, Y. W. (Wayne State Univ., Detroit). Phys. Rev., B; 7: No. 1, 150-6(1 Jan 1973).

The parallel nucleation field of N–S–layered samples was studied as a function of the ratio of the thickness of the superconductor d_s to its coherence length ξ_s. The ratio d_s/ξ_s for each sample was varied typically from 1.2 to 2.5 by controlling the temperature. This allowed investigations of each sample in the thin limit ($d_s < 1.84\xi_s$) as well as in the thick limit ($d_s > 2\xi_s$). The experimental results are compared with the theories of Fink and Martinoli and Fink and Presson. The supposed limits of theoretical validity are carefully examined in terms of d_s/ξ_s. For $d_s/\xi_s < 1.8$ the theory of Fink and Martinoli is satisfactory, while for $d_s/\xi_s > 2.1$, the Fink–Presson theory works well. (auth)

13341 MAGNETIC BEHAVIOR OF TYPE-II SUPERCONDUCTORS WITH SMALL GINZBURG–LANDAU PARAMETERS. Auer, J.; Ullmaier, H. (Kernforschungsanlage, Juelich, Ger.). Phys. Rev., B; 7: No. 1, 136-45(1 Jan 1973).

Type-II superconductors with $\kappa \approx 1$ exhibit a first-order phase transition at H_{c1}, which is due to an attractive interaction between flux lines. This behavior shows up as a discontinuous increase of the flux density from zero to a certain value B_0. B_0 was measured as a function of temperature T, Ginzburg–Landau parameter κ, and impurity parameter $\alpha = 0.882\ \xi_0/l$, and the critical values of these parameters were determined below which a first-order transition occurs at H_{c1}. The dependence of the parameters κ_1 and κ_2 on l and T was investigated further, and it is shown that only the condition $\kappa_1(T) = 1/\sqrt{2}$ determines the transition from type-I to type-II behavior. Comparison of the experimental results with recent theoretical treatments shows only qualitative agreement. (auth)

13342 ULTRASONIC-SURFACE-WAVE ATTENUATION OF GAPLESS SUPERCONDUCTORS. Kraetzig, E. (Philips Forschungslaboratorium, Hamburg). Phys. Rev., B; 7: No. 1, 119-29(1 Jan 1973).

The ultrasonic attenuation of gapless superconducting films was measured with acoustic surface waves. The following systems were investigated: thin films in parallel and perpendicular magnetic fields, superconductors in close contact with magnetic layers, and films showing surface superconductivity. Qualitatively the experiments exhibit the characteristic features derived theoretically for gapless superconductors. But quantitative comparisons show that the measured pair-breaking effect is stronger than expected from theory in all cases investigated. (auth)

13343 THERMOCONDUCTIVITY OF TWO-ZONE SUPERCONDUCTORS WITH IMPURITY. Moskalenko, V. A.; Ursu, A. M. (Inst. of Applied Physics, Kishinev, USSR). Teor. Mat. Fiz.; 13: No. 2, 222-40(Nov 1972). (In Russian).

An expression of the coefficient of the electron thermal conductivity of two-band superconductors with impurities is given. The overlap of energy bands in the vicinity of Fermi surface, as well as the process of intraband and interband scattering of electrons by impurities, are taken into consideration. It is shown that the individual bands generally speaking, do not contribute because of interband scattering. The obtained expressions contain, as a special case, the known result for the one-band model. The electron thermal conductivity of a two-band normal metal is also calculated. (auth)

13344 FLUCTUATION-INDUCED CONDUCTIVITY OF A SUPERCONDUCTOR ABOVE THE TRANSITION TEMPERATURE. Craven, R. A.; Thomas, G. A.; Parks, R. D. (Univ. of Rochester, NY). Phys. Rev., B; 7: No. 1, 157-65(1 Jan 1973).

Paraconductivity studies were made on Al films in regimes of temperature and magnetic field strength, which allow a straightforward comparison with the theoretical predictions of Aslamazov and Larkin, Maki and Thompson, and Patton. The results of previous experiments in a variety of pair-breaking regimes are reviewed briefly and in some cases reinterpreted in the context of recent developments in the theory. A comprehensive interpretation of most of the existing data is possible if one considers both Patton's recent calculation and the role of thermal phonons. (auth)

13345 MEASUREMENT OF THE FLUX FLOW VELOCITY IN SUPERCONDUCTING FILMS BY A TIME-OF-FLIGHT METHOD. Kaugerts, J. Hoboken, NJ; Stevens Inst. of Tech. (1972). 127p. University Microfilms Order No. 72-31,167.

Thesis.

The flux flow velocity was investigated by means of a time-of-flight method in superconducting films of tin for the temperature range exhibiting flux flow, namely $T > 0.9T_c$, where T_c is the film's critical temperature. Flux tubes are produced on the left side of the film by a 1.5 μs current pulse through a toroidal drive coil. A constant current through the tin sample produces a Lorentz force on the flux tubes which begin to move to the right across the film when the pinning current is exceeded. A movable pickup coil is used to sense their arrival and the flux flow velocity is then defined as the slope of a position versus arrival time plot. Velocities for both the leading edge and maximum of the flux pulse are found to be rather independent of position for sample currents not too near the pinning current. Typical values for the flux flow velocity are 1×10^5 cm/sec to 3×10^5 cm/sec. (TSS) (Diss. Abstr. Int., B)

13346 $H_c(\theta)$ AND TINKHAM'S FORMULA FOR HIGH-FIELD SUPERCONDUCTORS. Aoi, Koya (Institut Max von Laue–Paul Langevin, Garching, Ger.); Meservey, R.; Tedrow, P. M. Phys. Rev., B; 7: No. 1, 554-6(1 Jan 1973).

Measurements are reported of the angular dependence of the upper critical field $H_c(\theta)$ of two-dimensional high-field superconductors (thin Al films). The results are found to be in good agreement with the theory of Fulde and Maki and of Werthamer, Helfand, and Hohenberg. It is shown that, unless the sample is very dirty and the temperature is low ($T < T_c$), Tinkham's formula, which was originally derived without including Pauli paramagnetism, describes well the angular dependence even in the case where H_c is limited by Pauli paramagnetism. It is also shown that in a thin film, in contrast to a bulk material, Pauli paramagnetism can limit $H_{c\|}$, even at temperatures close to T_c. (auth)

13347 SUPERCONDUCTIVITY IN β-PHASE GALLIUM. Parr, H.; Feder, J. (Univ. of Oslo). Phys. Rev., B; 7: No. 1, 166-81(1 Jan 1973).

An experimental study of the superconducting properties of small single spheres of β-gallium has been made. Some spheres exhibited little superheating and went into the intermediate state so that $H_c(T)$ could be determined, giving $H_0 = 538 \pm 5$ Oe. The deviation of $H_c(T)$ from a parabolic temperature dependence is positive, indicative of strong-coupling superconductivity. T_c is 5.90 ± 0.03 K. For temperatures close to T_c, ideal superheating and supercooling are observed in the best spheres, allowing the determination of the Ginzburg–Landau parameter $\kappa = 0.141 \pm 0.002$. The variation with temperature of the signal difference between the superconductive and normal states determines the penetration depth of the magnetic field, giving $\delta_0 = 800 \pm 100$ Å. When the finite penetration depth is taken into account, agreement is obtained between the extrapolated values of $\kappa_{sc}(T)$ and $\kappa_{sh}(T)$ at T_c. (auth)

13348 TRANSVERSE AND LONGITUDINAL ULTRASONIC ATTENUATION MEASUREMENTS OF THE SUPERCONDUCTING ENERGY GAP IN HIGH-PURITY RHENIUM. Robinson, D. A.; Levy, M. (Univ. of Wisconsin, Milwaukee). J. Low Temp. Phys.; 9: No. 5-6, 415-24(Dec 1972).

The attenuation of transverse and longitudinal waves propagating along the c axis in high-purity rhenium was measured in the normal and superconducting states. In the superconducting state the attenuation was compared with the simple BCS theory using as adjustable parameters the gap parameter and the residual attenuation at T_c (for transverse waves). Using transverse-wave attenuation a gap parameter of 3.50 ± 0.10 was found, while the longitudinal

attenuation data yielded a gap parameter of 2.90 ± 0.10. At present, the only apparent explanation for this difference is that the integrals for transverse- and longitudinal-wave energy loss in an ultrasonic wave contain different azimuthal angle dependencies and thus average an anisotropic energy gap differently. (auth)

13349 MAGNETIC FIELD AND TEMPERATURE DEPENDENCE OF THE KNIGHT SHIFT IN SUPERCONDUCTORS OF SMALL DIMENSIONS. Zhogolev, D. A. (Inst. for Physical Chemistry, Kiev); Glasser, M. L. J. Low Temp. Phys.; 9: No. 5-6, 347-57(Dec 1972).

The magnetic field dependence of the paramagnetic Knight shift in weak-coupling superconductors is evaluated within the framework of the BCS–Gor'kov theory for samples of small dimensions. The behavior of the monotonic and oscillatory parts of the Knight shift is examined in detail in the regimes $T \to 0$ and $T \to T_c^-$. (auth)

13350 KINETICS OF DESTRUCTION OF TYPE-I SUPERCONDUCTIVITY BY A CURRENT IN A WIRE SUBMITTED TO A LONGITUDINAL MAGNETIC FIELD. Rothen, F. (Univ., Lausanne, Switzerland). J. Low Temp. Phys.; 9: No. 5-6, 359-88(Dec 1972).

The dynamics of the destruction of type-I superconductivity are studied for the case of a cylindrical wire submitted both to a current and to a longitudinal magnetic field $H_{||}$. During the penetration of the flux into the cylinder, the component of the magnetic induction parallel to the axis increases as one approaches the axis: this is a consequence of the special form of Ampère's law in the intermediate state. The relation of this phenomenon with the paramagnetic effect is discussed. (auth)

13351 FIELD DISTRIBUTIONS IN THE VICINITY OF A SUPERCONDUCTING FLUX EXCLUSION TUBE. Martin, F.; St. Lorant, S. J. (Stanford Univ., CA). J. Appl. Phys.; 44: No. 1, 460-4(Jan 1973).

The distributions of the magnetic field inside and around a superconducting flux exclusion tube due to currents induced in the material by an external magnetic field are examined. A simple macroscopic model for the superconductor is assumed, based on the concept of a field-dependent critical current density, and London's equations are used to calculate the magnetic potentials in the three regions of interest. The magnetic field inside the tube was mapped using an electron beam, and the results compared with the calculations. It is concluded that the major contribution to the magnetic field present in the tube can be ascribed to the induced dipole and sextupole current distributions in the superconductor. By contrast, the effect of direct field penetration through the narrow slits in the structure is very small. (auth)

13352 SPIN POLARIZATION OF ELECTRONS TUNNELING FROM FILMS OF Fe, Co, Ni, AND Gd. Tedrow, P. M.; Meservey, R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., B; 7: No. 1, 318-26(1 Jan 1973).

The spin polarization of electrons tunneling from films of Fe, Co, Ni, and Gd to superconducting Al films is determined from conductance measurements. The phenomenological theory of superconducting–normal-metal tunneling is modified to describe superconducting-ferromagnetic tunneling in a magnetic field. The experimental technique and the method of analysis of the conductance curves to obtain the electron polarization are both described. The observed polarization is positive (majority spin direction predominating) for all the metals; the values obtained were Fe, +44%; Co, +34%; Ni, +11%, and Gd, +4.3%. (auth)

13353 NEW METHOD OF IMPROVING THE STABILITY OF SUPERCONDUCTORS AGAINST FLUX JUMPING. Sutton, J. (Univ. of Wisconsin, Madison). J. Appl. Phys.; 44: No. 1, 465-71(Jan 1973).

The threshold magnetic field for flux jumping in a bulk irreversible type-II superconductor is known to be independent of its bulk critical current density. The present analysis shows that the flux jump field should be enhanced in a laminated superconductor in which the surface layer has a lower critical current density than the underlayer. For very large critical current density ratios, the limiting enhancement is 41%; for a 1:4 ratio the improvement is 32%. Experiments on laminated samples of Nb–48 wt % Ti alloys demonstrate an improvement in stability which is in good agreement with the theory. The technique may be useful in increasing the overload current rating of an ac superconducting power cable. (auth)

13354 THERMALLY AND MAGNETICALLY STABLE FLUX FLOW STATE IN TYPE-II SUPERCONDUCTOR. Onishi, T.; Miura, K. (Electrotechnical Lab., Tokyo). J. Appl. Phys.; 44: No. 1, 455-9(Jan 1973).

Behaviors of flux flow states under thermal or magnetic disturbances were studied using a Pb–In–Sn superconductor with the property $\partial J_c/\partial T > 0$. Existence of the previously reported stable flux flow states was confirmed clearly. When heating the sample the flux flow voltages decrease stably to zero (recovery of superconducting state). Also, flux flow states are found to be stable against magnetic field sweeping. They further indicate that magnetization will increase with increasing field sweep rates. (auth)

13355 SURFACE SUPERCONDUCTIVITY AND PINNING SITES IN TYPE-II SUPERCONDUCTORS. Furtado, C. S. (Univ., Coimbra). J. Low Temp. Phys.; 9: No. 5-6, 513-17(Dec 1972).

Surface superconductivity was investigated by measuring the real and imaginary parts of the magnetic permeability at small, low-frequency magnetic fields. The samples used were cylinders of $Ta_{92}Nb_8$, $Ta_{95}Nb_5$, and pure niobium which have suffered different bulk and surface treatments. From the measurements the conclusion is drawn that pinning sites at the surface are needed for the existence of surface superconductivity. (auth)

13356 LONG-RANGE ORDER IN SUPERCONDUCTING INTERCALATED LAYER COMPOUNDS. Tsuzuki, T. (Univ., Stuttgart). J. Low Temp. Phys.; 9: No. 5-6, 525-38(Dec 1972).

The correlation of the order parameter is studied in layer compounds in which adjacent metallic layers are coupled by Josephson coupling. It is shown that the long-range order is established over the whole system due solely to this coupling, even if very weak. The correlation length is anisotropic. The anisotropy ratios are related to the coupling strength. (auth)

13357 PROBLEM OF HIGH-TEMPERATURE SUPERCONDUCTIVITY. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Annu. Rev. Mater. Sci.; 2: 663-96(1972).

The problem of high-temperature superconductivity is reviewed under the following headings: the origin and meanings of superconductivity, some remarks on the calculation of the critical temperature, and the exciton mechanism of superconductivity. (56 references) (M.H.R.)

13358 INFLUENCE OF THERMAL TREATMENT ON THE SUPERCONDUCTING PROPERTIES OF NIOBIUM ALLOYS. Baron, V. V.; Bychkova, M. I.; Savitskii, E. M. Fiz. Khim. Obrab. Mater.; No. 2, 85-90(1972). (In Russian).

In niobium alloys with 60 to 80% Ti, the critical current density (J_c) increased to 10 A/cm² as a result of heat treatment at 350 to 450°C. This change in J_c was attributed to the separation of an α-phase in the bcc matrix. The optimum diameter of the α-phase was 10^{-5} to 10^{-6} cm, and their concentration was about 10^{11}/cm². A similar separation of a low-temperature phase in a superconducting matrix in ternary systems may be utilized for raising the critical current density. In the Nb–Zr system the original bcc solid solution became two bcc solid solutions and resulted in an increase in J_c. (tr-auth)

13359 SUPERCONDUCTIVITY AND PHONON SOFTENING. Allen, P. B. (State Univ. of New York, Stony Brook); Cohen, M. L. Phys. Rev. Lett.; 29: No. 24, 1593-6(11 Dec 1972).

A new formula is derived that relates changes in electron–phonon coupling strength λ to shifts in phonon frequencies. Using this formula, the superconducting transition temperature T_c is discussed for bcc transition metals and rock-salt-structure transition-metal carbides. (auth)

13360 HOPPING CONDUCTION THROUGH LOCALIZED STATES IN Nb/Al_2O_3 FILMS. Devenyi, A. (Univ., Karlsruhe, Ger.); Manaila-Devenyi, R.; Hill, R. M. Phys. Rev. Lett.; 29: No. 26, 1738-41(25 Dec 1972).

Electrical conduction in Nb/Al_2O_3 cermet films at low temperatures shows the presence of a new form of hopping conduction through localized states. In this mechanism the dielectric plays an essential role, behaving like an amorphous wide-band-gap semiconductor and acting as host to a distribution of localized states due to Nb dispersed, on an atomic scale, in the alumina matrix. (auth)

13361 LOW-FREQUENCY MAXIMA OF THE DENSITY OF STATE OF PHONONS. HARMONICS AND SUBHARMONICS OF THE ENERGY GAP OF Nb_3Sn. Vedeneev, S. I.; Golovashkin, A. I.; Motulevich, G. P. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 4, 152-4(20 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 4, 216-19(20 Aug 1972).

The differential conductivity (dI/dV) and its derivative (d^2I/dV^2) for Nb_3Sn/Pb junctions was investigated with micro-short-circuits. The dI/dV curve for low voltages ($V < 2\Delta$) show subharmonics

at $V_n = (\Delta_{eff} + \Delta_m/n)$. The amplitude of the maxima decreases very slowly, and high-order subharmonics could be observed. The d^2I/dV^2 curve for $V > 2\Delta$ show a jump at $V_{ph} = \Delta_{ph} + \Delta_{eff} + \Delta_m$ where $\Delta_{ph} = 6.2 \pm 0.6$ mV, and also a second small jump at $\Delta_{ph} = 3.5$ MeV. Harmonics $V_m = M\Delta_{eff}$ were also observed up to m = 10. (DLC)

13362 KINETICS OF PLASTIC DEFORMATION AT SUPERCONDUCTING TRANSITIONS. Bobrov, V. S.; Gutmanas, E. Yu. (Inst. of Solid State Physics, Chernogolovka, USSR). Phys. Status Solidi (b); 54: No. 2, 413-24(1 Dec 1972).

An analysis was carried out of the influence of the superconducting (SN and NS) transitions on the kinetics and parameters of plastic deformation for the models of viscous and thermally activated dislocation motion. Experimental investigations were performed on Pb single crystals at 4.2°K. The experimental ratio of plastic strain rates in normal and superconducting states in the point of SN transition corresponds to the change of electronic drag coefficient according to the BCS theory. The experimental results are in a better agreement with the analytical expressions obtained for the model of viscous dislocation motion. (auth)

13363 POSSIBILITY OF AN ORIENTATIONAL PHASE TRANSITION IN GRANULAR SUPERCONDUCTORS. Slusarev, V. A.; Burakhovich, I. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi (b); 54: No. 2, K103-6(1 Dec 1972).

Some types of granular superconductors can be treated as a system of superconducting grains connected by Josephson junctions. Thus, the system of a granular superconductor is reduced to that of interacting planar rotators, and equations are given for the energy of their orientational interaction and the kinetic energy. If the coupling energy of a rotator becomes comparable with temperature, a phase transition due to orientational ordering occurs, and equations are derived for the temperature of the transition into the ordered state, T_λ. (DLC)

13364 INFLUENCE OF CRYSTAL LATTICE DEFECTS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE. Izyumov, Yu. A. (Inst. of Metal Physics, Moscow). Fiz. Metal. Metalloved.; 33: No. 5, 908-20(May 1972). (In Russian).

The influence of temperature change of the superconducting transition point in a crystal was calculated, when the crystal contained one of three randomly distributed defects: point, line, and plane. The calculation was carried out in the statistical approximation, in which there was considered only the change in electron states, because of electron scattering by defects, without allowing for change in lattice dynamics. The relative lowering of the transition temperature is of the order of $1/\tau\omega_0 \ln \omega_0/T_c^0$, where T_c^0 is the superconducting transition temperature in the ideal crystal, ω_0 is the Debye frequency, and τ is the time between collisions of an electron with defects. (tr-auth)

13365 CRITICAL BEHAVIOUR OF V_3Si AND Nb_3Sn UNDER UNIAXIAL TENSION IN TRANSVERSE MAGNETIC FIELDS. Pulver, M. (Univ., Giessen, Ger.). Z. Phys.; 257: No. 3, 261-71(1972). (In German).

The critical data of superconductivity, i.e., temperature, magnetic field, and current, were investigated on V_3Si single crystals and V_3Si and Nb_3Sn diffusion wires in transverse magnetic fields under uniaxial tension. The values of all the critical parameters were reduced under the influence of the tension. A comparison of the results, obtained for the single crystals and the diffusion wires, led to an understanding of some anomalies in the behavior of the diffusion-wire samples. (auth)

13366 SUPERCONDUCTIVITY AND MAGNETIC PROPERTIES OF QUASI-BINARY ALLOYS IN THE Mo_2C–Re AND W_2C–Re SYSTEMS. Khan, H. R. (Forschungsinstitut fuer Edelmetalle und Metallchemie, Schwaebisch Gmuend, Ger.); Raub, C. J.; Lawson, A. C. Z. Metallk.; 36: No. 12, 814-17(Dec 1972). (In German).

The hexagonal carbides Mo_2C and W_2C form a continuous solid solution with rhenium as established by x-ray diffraction methods. The T_c behavior is different for Mo_2C-Re and W_2C-Re alloys. Two T_c maxima exist at 40 at.-% Mo_2C and 20 at.-% Mo_2C with a minimum at 30 at.-% Mo_2C. One flat maximum occurs at 50 at.-% W_2C. The variation of the room temperature magnetic susceptibility χ_m with Re-concentration is similar to that of T_c for the Mo_2C-Re alloys but χ_m increases continuously in the case of W_2C-Re system. The results are discussed in terms of McMillan's theory, using microhardness measurements. (auth)

13367 STRUCTURE OF SUPERCONDUCTING ALLOYS 35BT, 50BT, AND 65BT. Kadykova, G. N.; Fedotov, L. N. Fiz. Metal. Metalloved.; 33: No. 4, 708-14(Apr 1972). (In Russian).

The structure of the superconducting alloys 35BT, 50BT, and 65BT (35, 50, and 65% Nb, Ti, and small additions of Zr) following cold deformation and low-temperature annealing was studied by x-ray, electron-microscope, dilatometry, and resistance techniques. Cold, deformed 30% Nb alloy contains a diffusing ω phase, which forms α phase on heating. In cold, deformed 50BT alloy a small quantity of some "intermediate" phase was noted. After annealing at 450°C, some α phase and intermediate phase separated, uniformly distributed in the matrix. In cold-deformed 65BT, the intermediate phase was observed only in a region of great dislocation density. (tr-auth)

13368 PHASE TRANSITION OF THIN-FILM SUPERCONDUCTING CYLINDERS IN A MAGNETIC FIELD. II. ANGULAR DEPENDENCE. Meservey, R. (Massachusetts Inst. of Tech., Cambridge); Meyers, L. Phys. Rev., B; 6: No. 7, 2632-42(1 Oct 1972).

The normal-superconducting phase boundary for a thin-film microcylinder was measured in a magnetic field $\vec{H}$ making an angle θ with the cylinder's axis. The depression of the transition temperature for small values of transverse field H_t was proportional to H_t^2 as predicted by Tinkham, and equaled the predicted magnitude. At larger values of H_t there was a sudden discontinuity of slope in the T_c-vs-H^2 curve at a critical value of the transverse field H_{tc}. This discontinuity in slope apparently corresponds to a change from a superconducting state with uniform field penetration in the transverse direction to one with a single row of transverse vortices, the transverse-angular-momentum quantum number of the carriers changing from 0 to 1. A peculiar splitting of the flux-quantization resistance maxima was observed in the neighborhood of H_{tc} and qualitatively explained. (auth)

Equipment and Devices

13369 GLASS–CERAMIC CAPACITANCE THERMOMETER (Engineering Materials). (Minnesota Univ., Minneapolis. School of Physics and Astronomy). (CAPE-2297).

2 drawings.

It was found that the capacitance of a Corning type 1100 capacitance thermometer depends linearly on temperature from .007 to .025°K with an apparent sensitivity $dC/CdT \simeq -10^{-4}$/mK. (auth)

13370 MICROWAVE MIXING IN JOSEPHSON JUNCTIONS. Russer, P. (Lehrkanzel fuer Physikalische Elektronik, Vienna). Acta Phys. Austr.; 35: No. 1-2, 140-9(1972). (In German).

The direct-current voltage characteristics of Josephson junction are theoretically calculated on the analog computer for the case of two irradiating microwave frequencies. The possibility of an increase of the detection sensitivity by an additional irradiated microwave signal is discussed. (tr-auth)

13371 MONITORING OF VOLTAGE STANDARD BY MEANS OF JOSEPHSON EFFECTS. Kose, V.; Melchert, F.; Fack, H.; Hetzel, W. PTB Mitt.; 82: No. 4, 230-2(Aug 1972). (In German).

An experimental setup is described with which the stability of the PTB voltage standard, consisting of a group of Weston cells, can be monitored with a total uncertainty (1 σ) of 4 parts in 10^8 by means of the ac Josephson effect. The measured quotient of the fundamental constants 2 e/h is given by 2 e/h = (483,593.606 ± 0.020) GHz/V_{PTB}. (auth)

13372 CRITICAL MAGNETIC FIELDS OF Cu/Pb/Cu PROXIMITY-EFFECT SANDWICHES STUDIED BY ACOUSTIC SURFACE WAVES. Jain, M. C.; Tilley, D. R. (Univ. of Essex, Colchester, Eng.). J. low Temp. Phys.; 9: No. 5-6, 499-511(Dec 1972).

The temperature dependence of the surface-wave attenuation in Cu/Pb/Cu sandwiches, in the absence of a magnetic field, agrees well with the BCS expression. The temperature dependence of the parallel and perpendicular critical fields is compared with expressions derived from the Ginzburg–Landau theory. Satisfactory agreement is obtained, provided that for the thinner specimens the mean free paths in the proximity-effect sandwich is taken to be somewhat smaller than the values found for monitor strips. This implies that some interdiffusion between the Pb and the Cu is taking place. (auth)

13373 DESIGN AND TESTING OF ALTERNATORS WITH SUPERCONDUCTING FIELD WINDINGS. Heise, C. J. (Army Mobility Equipment Research and Development Center, Fort Belvoir, VA); Ferrick, J. H.; Teno, J.; Hatch, A. M. pp 2.81-8 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Design and test data are presented for experimental alternators

with superconducting field windings. Two designs are compared, the first being iron-free, and the second incorporating an iron-core armature. The outside dimensions are identical for the two alternators. Both designs incorporate stationary superconducting field windings located inside of rotating, air-cooled, ambient-temperature armatures. In both cases, the design speed is 12,000 rpm and the frequency 400 Hz. The effect of the iron core on alternator performance is determined by both analytical and experimental means. Both steady-state and transient test data are presented. Comparisons are made between predicted and observed data. Testing accomplished on the iron-core machine includes steady-state operation producing power in excess of 16 kW. The extrapolation of these designs to higher power levels is discussed. Results confirm that significant weight saving and size reduction over conventional alternators are attainable for a wide range of applications. (auth)

13374 CONVERSION OF ELECTROMAGNETIC INTO ACOUSTIC ENERGY VIA INDIUM FILMS. Zemel, A.; Goldstein, Y. (Hebrew Univ., Jerusalem). Phys. Rev., B; 7: No. 1, 191-200 (1 Jan 1973).

Transverse acoustic waves were generated electromagnetically at 9 GHz using thin indium films on silicon substrates. Measurements of the conversion efficiency α of electromagnetic into acoustic energy were made as a function of temperature, magnetic field, and microwave power. The highest α found above the superconducting transition temperature T_c of indium was comparable to that of quartz transducers. Below T_c, α decreases rapidly and becomes magnetic field and microwave power dependent. At low powers a good agreement was found between experiment and the theory of Abeles with respect to both the value and temperature dependence of α. This agreement shows that the generation of the acoustic waves is due primarily to diffuse scattering of electrons at the surfaces of the film. To fit the theory to the experiment, it had to be assumed that diffuse surface scattering persists below T_c as well and thus it is concluded that pair scattering at the surface does not conserve momentum. In addition, the results show that α is still appreciable at temperatures well below T_c and thus transverse-phonon generation may possibly be one of the important loss mechanisms in superconducting cavities. (auth)

13375 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES. 2. A MODEL FOR THE OPERATION OF PARTLY RESISTIVE SUPERCONDUCTING POINT CONTACT QUANTUM INTERFERENCE DEVICE. Park, J. G. (Imperial Coll. of Science and Tech., London); Slettenmark, B. FOA (Forsvarets Forsk.) Rep.; 6: No. 9, 1-12(Aug 1972).

A model for the operation of a partly resistive, superconducting point contact quantum interference device is presented. A general response function is calculated, and approximate expressions for the frequency dependence and noise properties at high and low frequencies are given. A novel, partly resistive double-hole device is described, and the obtained experimental results are compared with the predictions of the model. The experimental observations agree quite well with the given model in all respects, allowing for one possible exception, where the observed noise signal appears to be about one order of magnitude smaller than expected. The model is also used to give a different interpretation of some published experimental observations on a resistive SQID. (auth) (Sweden)

13376 TEMPERATURE CONTROLLER FOR DILUTION REFRIGERATORS. Burgess, A. E.; Crooks, M. J. (Univ. of British Columbia, Vancouver). Rev. Sci. Instrum.; 43: No. 11, 1718-19(Nov 1972).

An electronic analog device for automatically controlling the mixing chamber temperature of a dilution refrigerator is described. A self-inductance magnetic thermometer is used as the temperature sensing element. Using this device we were able to hold the mixing chamber temperature changes to less than 0.1 mK for periods of up to 12 h in the temperature range between 0.4 and 0.1 K. (auth)

13377 BELLOWS SEAL SUPERFLUID VALVE. Hallock, Robert B. (Univ. of Massachusetts, Amherst). Rev. Sci. Instrum.; 43: No. 11, 1713-14(Nov 1972).

A superfluid-tight valve that utilizes a bellows is described. Features of the valve include a nonrotating seal and ready interchangeability of parts. (auth)

13378 ACOUSTIC DEVICE FOR DETERMINING THE ISOTOPIC RATIO OF A ^{3}He–^{4}He GAS. Fraser, J. C. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum.; 43: No. 11, 1692-4(Nov 1972).

An acoustic device is described which measures the ^{3}He concentration of a ^{3}He–^{4}He gas mixture. The device was designed to provide an inexpensive system to continuously monitor the operation of a ^{3}He–^{4}He dilution refrigerator. The isotopic fraction may be easily measured to a precision of 1%. (auth)

13379 DESIGN AND HIGH-FREQUENCY RESPONSE OF RESISTIVE SQUID FREQUENCY CONVERTERS. Fife, A. A.; Gygax, Suso (Simon Fraser Univ., Burnaby, B. C.). J. Appl. Phys.; 43: No. 5, 2391-2405(May 1972).

Several resistive SQUID frequency converters (R-SQUID) have been constructed and their properties studied in the frequency regimes 26.5 to 40 and 67 to 73 GHz. A brief outline of the theory of the device is presented together with constructional details for a Nb/Nb point-contact version. The device response is complicated by the effects on the ac Josephson current of distributed circuit elements, and a broad range of complex behavior is presented which is only partially understood. A useful amplification effect for the detected signal has been discovered, which gives the device good broad range sensitivity (~10^{-7} to ~10^{-12} W/Hz$^{\frac{1}{2}}$) and reasonably narrow linewidths (Q value of ~10^4 at 70 GHz). (54 references). (auth)

PHYSICS (NUCLEAR)

13380 (EANDC(E)-150-U(Suppl.)) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EURATOM COMMUNITY FOR THE PERIOD JANUARY 1 TO DECEMBER 31, 1971. (European American Nuclear Data Committee). Oct 1972. 41p. Dep. NTIS (U. S. Sales Only).

ALUMINUM-27—neutron inelastic scattering at 0.8 to 13 MeV, fluctuation analysis of γ production cross section for, (E/T)
BORON-11—neutron reactions (n, α) at 14.1 MeV, differential cross sections for, (E)
BROMINE—neutron coherent scattering amplitude in powder of, (E)
CESIUM—neutron coherent scattering amplitude in powder of, (E)
CESIUM IODIDES—neutron reactions (n, α) at 14.2 MeV, differential cross sections for, (E)
CESIUM-133—neutron reactions (n,2n) at 12.7 to 18.3 MeV, excitation function for, (E)
GERMANIUM-70—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
GRAPHITE—neutron total cross section for, ultracold, (E)
IODINE—neutron coherent scattering amplitude in powder of, for, (E)
IODINE-127—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
IRON-54—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
IRON-56—neutron inelastic scattering at 0.8 to 13 MeV, fluctuation analysis of γ production cross section for, (E/T)
MAGNESIUM—neutron total iron section for, ultracold, (E)
MERCURY-204—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
MOLYBDENUM-92—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
NEUTRONS, FAST—reactions with nitrogen-15 at 0.9 to 8.8 MeV, resonance parameters for, (E)
NITROGEN-15—neutron reactions at 0.9 to 8.8 MeV, resonance parameters for, (E)
PLUTONIUM-241—neutron fission at 10 to 1200 keV, cross section relative to uranium-235, (E)
POTASSIUM—neutron coherent scattering amplitude in powder of, (E)
RUBIDIUM—neutron coherent scattering amplitude in powder of, (E)
RUBIDIUM-85—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
RUBIDIUM-87—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
SELENIUM-74—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
SODIUM—neutron coherent scattering amplitude in powder of, (E)
STRONTIUM-86—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
STRONTIUM-88—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E)
THALLIUM—neutron coherent scattering amplitude in powder of, (E)
URANIUM-235—neutron fission at 10 to 1200 keV, cross section relative to plutonium-241, (E)
YTTRIUM-89—neutron reactions (n, 2n) at 12.7 to 18.3 MeV, excitation function for, (E) (J.W.R.)

13381 (NP-19602) PROGRESS REPORT, 1971–1972. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 1972. 121p. Dep. NTIS (U. S. Sales Only).

Research progress at the Institute for Nuclear Physics Research in Amsterdam is reported. The research covers nuclear physics with fast electrons, nuclear reactions, beta- and γ-ray spectroscopy, in-beam spectroscopy, theoretical nuclear physics, nuclear and radiochemistry, development of instrumentation and experimental facilities, and design of a 300 MeV linear electron accelerator. Publications for the period July 1971 through July 1972 are listed. (J.W.R.)

Neutron Interactions with Matter

Refer also to abstracts 13821, 13910, and 14262.

13382 (IAE-2134) ANALYTICAL SOLUTION OF A SYSTEM OF MANY-GROUP DIFFUSION EQUATIONS. Gorodkov, S. S. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

An analytical solution by a system of many-group diffusion equations is found in two forms. The first, the simpler, can be utilized in the solution of tasks with a small number of groups. The second, the more unwieldly, allows the obtaining of a solution with a large number of groups by use of a computer. (tr-auth)

13383 (KFK-1258) PROGRAM FOR CALCULATION OF NEUTRON FLUX IN A ONE DIMENSIONAL, CONSISTENT P1-APPROXIMATION FOR MANY ENERGY GROUPS. Sanitz, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Aug 1972. 58p. (In German). Dep. NTIS (U. S. Sales Only).

A code for solving the one-dimensional neutron transport equation in many energy groups with consistent first-order Legendre expansion is described. The code is a generalization of a multigroup diffusion code. All generalizations are explained. For saving core memory the elastic scattering of hydrogen is treated recursively. The code is written in FORTRAN IV and is running on IBM /360 computers. (auth)

13384 (ORNL-TM-4015) ALC1 PROGRAM FOR CROSS-SECTION LIBRARY MANAGEMENT. Rhoades, W. A. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 15p. Dep. NTIS.

The ALC1 program moves nuclide-organized cross-section sets from cards, disk, or tape to tape, disk, or card data sets. Options provide facility for updating, deleting, merging, and listing data sets. The output is in a form suitable for the ANISN-related S_n codes. ALC1 has advantages of speed, convenience, and flexibility over other codes previously used for these functions. (auth)

13385 NEUTRON DIFFUSION AND FISSION: ACTIVE TRANSMISSION LINE ANALOG. Lindquist, C. S. (California State Coll., Long Beach, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 360-2(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Nuclear reaction problems involving neutron diffusion and fission may be readily characterized by active transmission lines. The neutron diffusion and fission analog are briefly described. (2 figures) (auth)

13386 MODEL SIMULATION OF THERMAL NEUTRON DIFFUSION. Starikov, V. N. At. Energ. (USSR); 33: No. 5, 924-5 (Nov 1972). (In Russian).

An algorithm was applied to a simple equation which described the steady-state diffusion of thermal neutrons in terms of the diffusion coefficient, the macroscopic absorption cross section, and the thermal neutron flux. Model simulation furnished the point of absorption in a homogeneous medium. (K.S.W.)

13387 CALCULATION OF THE ANISOTROPIC DIFFUSION COEFFICIENT. Takeda, T.; Sekiya, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 12, 697-704(Dec 1972).

The one-group anisotropic diffusion coefficient is calculated for slab and square lattice cells with use made of Benoist's formula. In utilizing the integral transport theory, only several collisions suffered by a neutron have hitherto been considered. In this paper, the integral theory is adopted, and the effect of an infinite number of collisions suffered by a neutron is considered, this being made possible by solving simultaneous equations. Further, the anisotropic scattering through the generalized first-flight collision probability is considered. Then the fundamental and the additional terms in the Benoist formula for slab and square lattice cells are estimated. (auth)

13388 SOLUTION OF THE NEUTRON DIFFUSION EQUATION IN AN INFINITE MEDIUM WITH A CYLINDRICAL HOLE. Wozniak, J. (Inst. of Nuclear Techniques, Krakow). Nukleonika; 17: No. 9, 433-7(1972).

A solution of the thermal neutron diffusion equation in the two-group approximation for an infinite medium with a cylindrical hole is given in the form of the Fourier–Bessel integral. The influence of the hole diameter is considered. The solution obtained may be used for the theoretical calibration of neutron moisture gages. (auth)

13389 CYLINDRICAL TRANSPORT KERNEL IN HETEROGENEOUS MEDIA. Clark, A. T. Jr. College Park, MD; Univ.

of Maryland (1972). 94p. University Microfilms Order No. 72-28,886.

Thesis.

A neutron transport kernel has been developed for use in computing single-collision fluxes from cylindrical shell sources in infinite arrays of cylindrical cells. The computation requires the use of a digital computer utilizing FORTRAN programming. The kernel has been tested by comparison with known results for neutron escape probabilities. (Diss. Abstr. Int., B)

13390 RECENT ADVANCES IN NEUTRON FLUX MEASUREMENT. Ferguson, A. T. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 219-31 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13391 THEORY OF COHERENT NEUTRON SCATTERING BY HYDROGEN-BONDED FERROELECTRICS AT LOW TEMPERATURES. I. GENERAL EXPRESSION FOR INELASTIC COHERENT SCATTERING OF SLOW NEUTRONS AND EFFECTIVE THERMAL FACTORS. Stamenkovic, S. (Boris Kidric Inst. of Nuclear Science, Belgrade). J. Low Temp. Phys.; 9: No. 5-6, 475-83(Dec 1972).

Differential cross section for inelastic coherent scattering of slow neutrons scattered by hydrogen-bonded ferroelectrics at low temperatures was evaluated. Quasi-spin form factors were calculated using the Blinc model. The proton (deuteron)–lattice interaction is taken into account, and an effective Debye–Waller factor is introduced. (auth)

13392 THEORY OF COHERENT NEUTRON SCATTERING BY HYDROGEN-BONDED FERROELECTRICS AT LOW TEMPERATURES. II. SCATTERING CHARACTERISTICS AND VARIOUS CONCEPTIONS OF THE TUNNELING QUASISPIN MODEL. Stamenkovic, S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Low Temp. Phys.; 9: No. 5-6, 485-94(Dec 1972).

To check experimentally the dispersion law of the polarization ("quasi-spin-wave-like") mode, the characteristics of quasi-elastic neutron scattering at small angles are studied in KDP-type ferroelectrics. The various conceptions of the tunneling quasispin model, the nature of the low-temperature polar phase, and the vibration of tunneling particles along the axis of anisotropy are discussed with reference to the coherent neutron scattering. (auth)

13393 INCOHERENT NEUTRON SCATTERING FOR LARGE MOMENTUM TRANSFER. II. QUANTUM EFFECTS AND APPLICATIONS. Sears, V. F. (Chalk River Nuclear Labs., Ont.). Phys. Rev., A; 7: No. 1, 340-348(Jan 1973).

The asymptotic expansion of the incoherent-scattering function in inverse powers of the magnitude of the momentum transfer κ, which was given in a previous article for simple classical liquids, is generalized within the Gaussian approximation to include quantum effects. Inverse-κ expansions are also obtained for the full width at half-maximum, the mean frequency, and the frequency of the maximum of the scattering function. The results are applied in the interpretation of recent neutron-inelastic-scattering data for liquid neon, liquid rubidium, and hydrogen gas. (auth)

13394 APPLICATION OF THE FINITE-ELEMENT METHOD TO TWO-DIMENSIONAL MULTIGROUP NEUTRON DIFFUSION. Semenza, L. A. Evanston, IL; Northwestern Univ. (1972). 79p. University Microfilms Order No. 72-32,573.

Thesis.

One-group and multigroup neutron diffusion problems in both x-y and r-z geometries are formulated and solved using the finite element method. The derivation of the linear triangular and bilinear rectangular element is developed along with that for an improved rectangular element. The finite element method is implemented in a two-dimensional multigroup neutron diffusion computer code, FEND. It utilizes standard source iteration techniques coupled with Cholesky reduction to solve the algebraic equations resulting from finite element discretization in both x-y and r-z geometries. In contrast to the finite difference method, arbitrarily shaped domains and material interfaces can be accurately described in the FEND code. Example problems using triangular, rectangular and composite meshes of triangles and rectangles for one-group and multigroup problems in x-y and r-z geometry are presented. Boundary conditions of zero flux, zero current and specified albedo conditions are used over the domain. Finite element calculations are slightly more accurate than finite difference calculations in situations where identical rectangular meshes are used. With the use of triangular elements to optimize nodal placement it is found that increased accuracy can be obtained even though the number of node points has been substantially reduced. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 13029, 13254, 13325, 13596, and 13641.

13395 (ORO-3491-20) 1972 PROGRESS REPORT FOR THE EXPERIMENTAL STUDY OF THE STRUCTURE OF NUCLEI AND THE INTERACTIONS OF INTERMEDIATE ENERGY PARTICLES. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct 1972. Contract AT(40-1)-3491. 117p. Dep. NTIS.

BERYLLIUM-9—proton reactions (p,pα) at 100 MeV, particle spectra from, (E)
CALCIUM-40—deuteron inelastic scattering at 69 MeV, DWBA analysis of, (E/T)
—deuteron reactions (d,t) at 69 MeV, DWBA analysis of, (E/T)
—deuteron elastic scattering at 69 MeV, optical model analysis of, (E/T)
CARBON-12—proton reactions (p,2p) at 85 MeV, particle spectra from, (E)
—deuteron reactions (d,p) at 69 MeV, DWBA analysis of, (E/T)
—deuteron elastic scattering at 69 MeV, optical model analysis of, (E/T)
—alpha elastic and inelastic scattering at 139 MeV, model analyses of cross sections for, (E/T)
—alpha reactions (α,He-3) at 139 MeV, model analyses of cross sections for, (E)
—helium-3 elastic and inelastic scattering at 101 MeV, cross sections for, (E)
DEUTERIUM—proton reactions (p,2p) at 65, 85, and 100 MeV, PWIA analysis of cross sections for, (E)
—proton reactions (p,ph) at 65 MeV, cross section for, (E)
FLUORINE-19—proton reactions (p,2p) at 85 MeV, particle spectra from, (E)
HELIUM-3—proton reactions (p,2p) at 65, 85, and 100 MeV, PWIA analysis of cross sections for, (E)
—proton reactions (p,ph) at 65 MeV, cross section for, (E)
—proton reactions (p,pd) at 65, 85, and 100 MeV, analysis of reaction mechanism in, (E)
—alpha elastic scattering at 140 MeV, phase shift analysis of, (E/T)
HELIUM-4—proton reactions (p,2p) at 65, 85, and 100 MeV, PWIA analysis of cross sections for, (E)
—alpha elastic scattering at 140 MeV, phase shift analysis of, (E/T)
INSTRUMENTS—development and Maryland University Department of Physics and Astronomy
NICKEL-58—alpha elastic scattering at 139 MeV, optical-model analysis for nuclear refraction effects in, (E/T)
URANIUM-226—alpha decay of, α energy and half-life for, (E)
URANIUM-238—alpha fission at 140 MeV, total and compound nucleus cross section for, (E)
ZIRCONIUM-90—deuteron elastic scattering at 69 MeV, optical model analysis of, (E/T) (J.W.R.)

13396 ^{3}He(p,2p)pn REACTION AT 35 MeV. Epstein, M. B. (California State Univ., Los Angeles); Slaus, Ivo.; Shannon, D. L.; (and others). Nucl. Phys.; A199: No. 2, 225-31(1973).

The differential cross sections for the reaction ^{3}He(p,2p)pn were measured at 35 MeV for the angular sets 35°–35°; 40°–40°; 45°–45°; 42°–30°; 45°–35°; 70°–35°. The data were compared to four-body phase-space calculations. Several deviations from the phase-space predictions were observed but no conclusive evidence for excited states in ^{3}He was found. (auth)

13397 PROJECTION METHOD, CRANKING CONDITION, AND COLLECTIVE ENERGY. Kuebler, Olaf (Univ., Heidelberg). Nucl. Phys.; A196: No. 1, 113-34(1972).

The method of variation after projection is investigated in general terms (no restriction to independent-particle type models being made). For simplicity only Abelian symmetry groups are considered. The resulting complicated variational equation for the intrinsic wave function can be treated by successive approximations. The zeroth order is equivalent to the conventional variational problem. The first-order intrinsic function is determined from an equation containing the effect of collective motion on the intrinsic dynamics of the system. It is shown that the first-order intrinsic function automatically obeys the cranking condition. The inertial parameter is expressed in terms of the first-order wave

function. It contains the Peierls–Yoccoz term and a term of the Thouless–Valatin form in addition to other terms. In all special cases considered, the Thouless–Valatin term is the dominating contribution while all other terms (nearly) cancel. Applying the method to translational motion, the exact total mass is obtained in lowest non-trivial order of the expansion. The case of a model molecule is studied; the values of the moment of inertia according to Peierls–Yoccoz, Thouless–Valatin and the present formalism are calculated and compared. (auth)

13398 DO THE EXPERIMENTS WITH SOLAR NEUTRINOS POINT TO THE EXISTENCE OF A RESONANCE IN THE $^3He + ^3He$ SYSTEM. Kopysov, Yu. S.; Fetisov, V. N. (Lebedev Physics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 39-41(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 58-60(5 Jul 1972).

In connection with the indicated possibility of explaining the experiments of Davis et al. (1971), searches for an exact position of the levels 1^+ and 0^+ with isospin T = 0 and T = 1 in ^6Li in the region E ~ 10 to 16 MeV are of interest. In principle, one can attempt to observe these levels in the reaction of inelastic electron scattering, which can lead to a monopole excitation of the α cluster in ^6Li, and also in the reaction $^3He(\alpha,n)^6Be$ with the aid of the spectrum of the emitted neutrons. (W.D.M.)

13399 NEUTRON–NUCLEUS TOTAL CROSS SECTIONS IN THE 10 TO 30 GeV/c MOMENTUM RANGE. McCorriston, T. P. Jr. Ann Arbor, MI; Univ. of Michigan (1972). 152p. University Microfilms Order No. 72-29,145.

Thesis.

The total nuclear cross sections for neutrons on protons, carbon, copper and lead were measured at mean neutron momenta of 11.8 GeV/c, 16.9 GeV/c, and 25.4 GeV/c. Also measured were the total cross sections for neutrons on deuterium at 16.9 GeV/c and on beryllium, aluminum, cadmium, and tungsten at 25.4 GeV/c. The experiment was conducted at the Alternating Gradient Synchrotron at Brookhaven National Laboratory. A total absorption spectrometer was used to select only the most energetic neutrons from the incident spectra. The measured nuclear cross sections are compared to the predictions of the Glauber multiple scattering model and are found to agree. A comparison of the momentum dependence of the measured cross sections with that predicted by two models of the inelastic shadow effect shows that this effect is too small to be resolved at the energies at which this experiment was performed. (Diss. Abstr. Int., B)

13400 FURTHER EVIDENCE FOR THE DOMINANCE OF NUCLEON–NUCLEON P-WAVE FORCES IN VECTOR POLARIZATIONS IN N–d SCATTERING BELOW 15 MeV. McKee, J. S. C.; Conzett, H. E.; Larimer, R. M.; Leemann, Ch. (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 24, 1613-16(11 Dec 1972).

Vector analyzing powers in deuteron–proton scattering were measured with polarized deuterons incident at 20 and 30 MeV. The results are in excellent agreement with very recent three-body calculations which clearly show that the nucleon–nucleon P-wave interaction is the dominant cause of the vector polarization in nucleon–deuteron scattering at these energies. (auth)

13401 INFLUENCE OF THE DEUTERON D-WAVE ON THE $^3He(d,p)^4He$ POLARIZATION RELATIONS. Ots, I. (Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 21: No. 3, 289-90(1972). (In Russian).

The effect of making an allowance for the D-wave of the deuteron on the polarization relations of the $^3He(d,p)^4He$ reaction was investigated. The argument is based upon expressions for the spin structure of the amplitude and polarization moments. A difficulty in the interpretation of the results is pointed out. (K.S.W.)

13402 ANGULAR DISTRIBUTIONS OF THE $^2H(d,\gamma)^4He$ REACTION. Poutissou, J. M.; Del Bianco, W. (Univ. of Montreal). Nucl. Phys.; A199: No. 3, 517-29(1973).

Angular distributions of γ rays from the $^2H(d,\gamma)^4He$ reaction were measured at the deuteron energies E_d = 6.05, 8.96, and 11.67 MeV with a 12.7 cm × 15.2 cm NaI(Tl) crystal enclosed in a Cherenkov anticoincidence shield. A least-square fit of the angular distributions indicates that the differential cross section is proportional to $\sin^2\theta \cos^2\theta$ and that the process proceeds through an E2 transition of the type $^1D_2 \rightarrow {}^1S_0$. (auth)

13403 SIMPLE THEORY OF THE PROTON–PROTON FINAL-STATE INTERACTION IN THE REACTION d + p → p + p + n. Matthaey, H. (Univ., Karlsruhe, Ger.); Zeh, H. D. Nucl. Phys.; A192: No. 1, 39-48(1972).

The amplitude for deuteron break-up in deuteron–proton collisions including Coulomb final-state interactions (in all partial waves) is derived analytically. The calculation is based on the assumption of a two-step reaction with a break-up mechanism of zero range. The nuclear final-state interaction is taken into account under the same approximations in the s-waves. A comparison with experiment indicates a clear improvement compared to the Watson–Migdal theory. (auth)

13404 POLARIZATION IN NEUTRON–PROTON SCATTERING AT 16.2 MeV. Garrett, R.; Chisholm, A.; Brown, D.; Daler, J. C.; Buergisser, H. N. (Univ. of Auckland, New Zealand). Nucl. Phys.; A196: No. 2, 421-32(1972).

The polarization in the scattering of neutrons from protons has been measured at a lab neutron energy of 16.2 MeV for the three c.m. angles 70, 100, and 130°, at which the measured polarizations were (+2.95 ± 0.86)%, (+1.84 ± 0.91)% and (+1.62 ± 0.99)% respectively. (auth)

13405 BREAK-UP REACTION $P_0 + d \rightarrow p_1 + p_2 + n$ AT E_0 = 16 MeV. Klein, H.; Eichnér, H.; Helten, H. J.; (and others) (Univ., Cologne). Nucl. Phys.; A199: No. 1, 169-85(1973).

The break-up reaction $p_0 + d \rightarrow p_1 + p_2 + n$ has been studied at E_0 = 16 MeV in kinematically complete p_1-p_2 coincidence experiments with special regard to n-p final-state interactions (f.s.i.) and p_1-p_2 quasifree scattering (q.f.s.). The absolute differential cross section has been measured for n-p f.s.i. c.m. production angles from 60 to 140° and for four pairs of angles with strong contributions due to q.f.s. Calculations with separable nucleon-nucleon potentials based on the Faddeev equations are in good agreement with the data obtained. In general, the shape of the experimental differential cross section is well reproduced. Discrepancies of up to 30% in the worst cases arise between the absolute values of the theoretical predictions and the experimental data. (auth)

13406 DOPPLER EFFECT IN THE EXTRACTION OF TOTAL NEUTRON CROSS SECTIONS FROM DEUTERIUM DATA WITH PARTICULAR EMPHASIS ON ASYMPTOTIC HADRON AND DEEP INELASTIC ELECTRON SCATTERING. West, G. B. (Stanford Univ., CA). Ann. Phys. (N. Y.); 74: No. 2, 464-502(Dec 1972).

The effects of nuclear Fermi motion on the extraction of high-energy neutron cross sections from deuterium data are discussed in some detail. Three examples are considered: resonance scattering, asymptotic hadron scattering, and deep inelastic electron scattering. In the first example it is shown in a very simple way how a nucleon resonance is broadened when viewed in the deuteron. Simple qualitative expressions are derived for the depression of the peak and the broadening of the width due to the Döppler shifting of the incident energy. For asymptotic hadron scattering, where total cross sections are generally very slowly varying, it is shown that there is a subtle effect, due to the threshold constraint on the total nucleon cross sections, which tends to deplete the total deuteron cross section. The size of this defect depends crucially upon the size of the high-momentum components in the deuteron wave function. The effect is capable of explaining the apparent energy and process dependence of the mean inverse square radius parameter which occurs in the Glauber screening formula. An estimate of the effect in total photoabsorption cross sections indicates that the proton–neutron difference may be considerably smaller than expected. In the third example, deep inelastic electron scattering, this threshold effect increases near the threshold region. This, together with the conventional smearing effect, is shown to simulate the shape of the apparent difference between the proton and neutron. The size of the overall effect again depends crucially upon the high momentum components in the deuteron. However, reasonable estimates indicate that there is a real proton–neutron difference, especially in the so-called low-ω region; the difference probably vanishes in the large-ω region. Several other effects in deep inelastic electron scattering are discussed: It is shown that a value of ω exists (the cross-over point, ω_c) at which the overall effect vanishes; that is, below ω_c the effect reverses sign and the neutron cross section now appears larger than it really is. In addition, an expression for the threshold behavior of the deuteron cross section is derived in terms of the threshold behavior of the nucleon cross sections and the asymptotic form of the deuteron elastic form factor. Finally, a series of wave function-independent sum rules is derived which relate the overall integrated depletion to the integrated deuteron cross section below the quasi-elastic peak. Such sum rules could be extremely useful in "measuring" the effects of the Fermi motion. Most of the discussions in the paper are of a qualitative nature. The paper was written with the experimentalist reader in mind. (16 figures) (auth)

13407 INEQUALITY RELATING THE GROUND-STATE ENERGIES OF TWO AND THREE BOSONS. Bruch, L. W.; Sawada, K. (Tokyo Univ. of Education). Phys. Rev. Lett.; 30: No. 1, 25-7(1 Jan 1973).

Sufficient conditions are reported for the validity of the inequality $E_0(3) \leq 3E_0(2)$ for the ground-state energies of two and three nonrelativistic identical bosons interacting via spherically symmetric pair potentials. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 12140, 12146, 12164, 13254, 13395, 13399, and 13631.

13408 (ANU-P-549) EXCITED STATES OF ^{16}O BETWEEN 13.5 AND 15.0 MeV. Martin, P.; Ophel, T. R. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 13p. Dep. NTIS (U. S. Sales Only).

A comprehensive analysis was performed of measurements of the $^{12}C(\alpha,\alpha_0)$ and $^{12}C(\alpha,\alpha')$ reactions within the range of incident α-particle energies between 8.5 and 10.5 MeV. A description of the experimental data was possible in terms of six levels of ^{16}O: 4^+ (13.8 MeV), 0^+ (14.0 MeV), 3^- (14.2 MeV), 4^+ (14.6 MeV), 5^- (14.6 MeV), and 6^+ (14.8 MeV). (auth)

13409 (CONF-720309-, pp 389-93) DEUTERON TRANSFER REACTION $2\ ^6Li \rightarrow 3\ \alpha$. Norbeck, E.; Gadeken, L. L. (Univ. of Iowa, Iowa City). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The deuteron transfer process in the $^6Li + ^6Li \rightarrow 3\ \alpha$ reaction was studied. Experimental data for incident energies of 2 and 6 MeV were analyzed using the plane wave Born approximation. The calculated and experimental contour plots are presented. (J.W.R.)

13410 (COO-1764-154) HIGH-LYING NEUTRON-HOLE STATES POPULATED IN THE REACTION $^{13}C(p,d)^{12}C$ AT 62 MeV. Parish, L. J. (Florida State Univ., Tallahassee. Dept. of Physics. Minnesota Univ., Minneapolis. School of Physics); Brown, R. A.; Eberhard, K. A. (Florida State Univ., Tallahassee. Dept. of Physics); Richter, A. (Argonne National Lab., Ill.); von Witsch, W. (Rice Univ., Houston, Tex. Dept. of Physics). 1972. 21p. Dep. NTIS.

The single-nucleon pickup reaction $^{13}C(p,d)^{12}C$ at 62 MeV was employed to study high-lying states in ^{12}C. States are seen at excitation energies E_X = 17.79, 18.84, 21.5, and 22.5 MeV in ^{12}C, and the lp neutron-hole strength found is in qualitative agreement with theoretical predictions. However, the lp neutron-hole strength at high excitation is distributed over more states than predicted by intermediate coupling shell model calculations. (auth)

13411 (JINR-P15-6771) STUDY OF THE REACTION $^{11}B(p,3\alpha)$. Dzhanobilov, K.; Komarov, V. V.; El Tahavi, M. S.; Saad, Kh. R.; Sizov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 20p. (In Russian). Dep. NTIS (U.S. Sales Only).

Coincidence spectra of two α particles from the reaction $^{11}B(p,3\alpha)$ at E_p = 2.0 and 2.65 MeV were measured by two-dimensional analysis. Experimental data are compared with calculations carried out according to many-particle scattering theory taking into account the interactions of all three pairs of α particles in a final state. A satisfactory agreement of experiment with theory is obtained. (auth)

13412 (LA-DC-72-1115) TRITIUM-PRODUCTION MEASUREMENT WITH APPLICATION TO FUSION REACTOR BLANKET DESIGN. Muir, D. W. (Los Alamos Scientific Lab., N. Mex.); Wyman, M. E. (Illinois Univ., Urbana). [nd]. 4p. (CONF-720942-1). Dep. NTIS.

From Seminar on nuclear data and neutronics of CTR blankets; Seattle, WA. (19 Sep 1972).

A 92.3 kg sphere of Li D was irradiated with a 14-MeV neutron source located at the center of the sphere. Samples of metallic ^7Li and natural Li were placed at radial positions from the source. After a total irradiation of 2×10^{15} source neutrons, the samples were analyzed for tritium content using absolute beta counting techniques. The tritium production rates in the samples were compared with integral calculations. The discrepancies between the shapes of the calculated and experimental radial distributions were large although the overall agreement was satisfactory. (J.W.R.)

13413 PHASE SHIFT ANALYSIS OF ELASTIC PROTON SCATTERING BY ^{12}C. Wienhard, K. (Justus Liebig Univ., Giessen, Ger.); Clausnitzer, G.; Hartmann, G. Z. Phys.; 256: No. 5, 457-66(1972).

Angular distributions of the polarization and cross section in $^{12}C(p,p)^{12}C$ were measured at 24 energies between 9.95 and 10.90 MeV. A phase-shift analysis of the data was carried out. The results show four resonances in ^{13}N at E_x = 11.40, 11.64, 11.67, and 11.82 MeV with spins $5/2^+$, $5/2^-$, $3/2^-$, and $3/2^+$. (auth)

13414 INVESTIGATION OF THE REACTIONS $^{12}C(d,p_0)^{13}C$ AND $^{12}C(d,p_1)^{13}C$ BY POLARIZED DEUTERONS. Borovlev, V. I.; Lopatko, I. D.; Andreev, G. B.; Slabospitskii, R. P. (Physical Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 966-9(Jun 1972). (In Russian).

An investigation of the reactions $^{12}C(d,p_0)^{13}C$ and $^{12}C(d,p_1)^{13}C$ was made by a polarized beam that was accelerated in a tandem generator. Angular distributions of the protons were measured in the region 30° to 150° for deuterons with incident energies E_d = 2.71, 2.86, 2.95, and 3.07 MeV. The asymmetry was measured at an angle of Θ_{lab} = 90° in the region E_d = 1.6 to 3.0 MeV. The vector analyzing power was obtained from the experimental data as a function of the deuteron energy and angle. The experimental data may be explained by interference of direct and compound processes. (4 figures) (auth)

13415 MEASUREMENTS OF NEUTRON ANGULAR DISTRIBUTIONS FROM THE $^7Li(p,n)^7Be$ REACTION. Elbakr, S. A.; van Heerden, I. J.; McDonald, W. J.; Neilson, G. C. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 105: No. 3, 519-23(1972).

The absolute 0° differential cross sections for the $^7Li(p,n_0)^7Be$ and the $^7Li(p,n_1)^7Be$ reactions were measured with a time-of-flight spectrometer at 0.1-MeV intervals from 2.20 to 5.50 MeV. Angular distributions of neutrons from both reactions were also measured at 0.2-MeV intervals from 2.60 to 5.40 MeV for the n_0 neutron group and from 3.20 to 5.40 MeV for the n_1 group. Absolute differential cross sections were obtained by normalization to the 0° measurement. The center-of-mass distributions were fitted with a Legendre polynomial series. Total (p,n) cross sections were obtained by integrating the angular distributions. The comparison between present and previous results revealed some disagreement in the shapes of angular distributions and in the magnitude of total cross sections for the $^7Li(p,n_1)^7Be$ reaction. (6 figures, 1 table) (auth)

13416 ELASTIC AND INELASTIC SCATTERING OF ^3He FROM ^{12}C AT 24.0, 29.2, 34.7, AND 39.6 MeV. Fujisawa, T.; Yamaji, S.; Matsuda, K.; (and others) (Inst. of Physical and Chemical Research, Wako, Japan). J. Phys. Soc. Jap.; 34: No. 1, 5-13(Jan 1973).

Measurements were made at angles of the center of mass extending from 14° to 128° or 172°. The yield of inelastic scattering at most angles was of the same order in the elastic scattering. A Thomas type spin-orbit coupling of the optical potential is useful for the elastic scattering at backward angles. Discrete and continuous ambiguities in the optical model parameters appeared in the analysis. The experimental values of inelastic scattering were predicted fairly well by the DWBA theory, and the deformation parameters β_2 were about 0.5. In the coupled channel analysis, the predicted values of elastic scattering were much different from the results of optical model analyses by coupling to the inelastic channel, and the potential whose imaginary part was shallower than that given by the optical model analysis gave better fit. The value of β must be -0.5 for 39.6 and 34.7 MeV. (auth)

13417 PHOTONEUTRON PRODUCTION CROSS SECTION IN ^9Be. Thomas, B. W.; Crawford, D. M.; Thies, H. H. (Univ. of Western Australia, Nedlands). Nucl. Phys.; A196: No. 1, 89-100(1972).

The photoneutron production cross section in ^9Be was measured with a synchrotron using energy sweeping. Neutrons were detected with a multi-BF_3-counter flat-response detection system. Under high resolution the cross section shows 23 maxima between 6 and 27 MeV which are caused predominantly by E1 transitions. (auth)

13418 RESONANCES IN THE $^{15}N(\alpha,\gamma)^{19}F$ REACTION BETWEEN E_α = 1.68 AND 2.72 MeV. Rogers, D. W. O.; Beukens, R. P.; Diamond, W. T. (Univ. of Toronto). Can. J. Phys.; 50: No. 20, 2428-43(15 Oct 1972).

Using the $^{15}N(\alpha,\gamma)^{19}F$ reaction, the properties of 6 levels between 5.3 and 6.2 MeV in ^{19}F were studied. In conjunction with previously reported restrictions on spins for these levels, measurements of branching ratios, radiative widths, and angular distributions were used to make the following spin-parity assignments; 5618 keV, $3/2^-$; 5938 keV, $1/2^+$; 6070 keV, $7/2^+$; 6088 keV, $3/2^-$; 6160 keV, $7/2^-$. The properties of these levels and that at 5336 keV were compared in detail to the various shell model calculations done for ^{19}F. The properties of the third $J^\pi = 7/2^+$ level at 6.07 MeV can be used to clear up some of the confusion caused by the first two $J^\pi = 7/2^+$ levels in ^{19}F and the properties

of the $J^\pi = 3/2^-$ levels confirm the fact that the weak coupling model does not explain the negative parity states outside the $K = 1/2^-$ band. (auth)

13419 SPECTROSCOPIC STUDY OF ^{18}F. I. THE ^{17}O(p,p)^{17}O AND ^{17}O(p,α_0)^{14}N REACTIONS. Sens, J. C.; Rietsch, F.; Pape, A.; Armbruster, R. (CRN, Strasbourg). Nucl. Phys.; A199: No. 2, 232-40(1973).

The ^{17}O(p,p)^{17}O and ^{17}O(p,α_0)^{14}N reactions were studied in the energy range E_p = 0.5 to 1.33 MeV. Excitation functions for elastic scattering measured at several angles give l_p values for six resonances and J^π; T values of 3^+; 1 and 2^+; 1 for the states at 6.16 and 6.28 MeV, respectively. For both reactions, J^π limitations were found for six resonant levels. The ^{17}O(p,α_0)^{14}N reaction also yields information on T-assignments and level formation parameters. Experimental results are discussed in terms of shell-model configurations. (auth)

13420 SPECTROSCOPIC STUDY OF ^{18}F. II. THE ^{17}O(p,γ)^{18}F REACTION. Sens, J. C.; Pape, A.; Armbruster, R. (CRN, Strasbourg). Nucl. Phys.; A199: No. 2, 241-56(1973).

Thirteen resonances corresponding to excitations between 6 and 7 MeV were observed in the ^{17}O(p,γ)^{18}F reaction between E_p = 440 and 1440 keV. For most of the levels, precise energies, branching ratios, and resonance strengths were determined. In some cases, natural resonance widths and transition strengths could be given. A reaction Q-value of 5603 ± 3 keV was found. Angular distributions of γ-rays and $\gamma-\gamma$ correlation measurements, together with ^{17}O(p,p) and ^{17}O(p,α_0) data, were used to determine J^π values and mixing ratios. The levels are discussed in terms of weak coupling shell-model configurations. (auth)

13421 NUCLEAR STRUCTURE OF ^{18}F. I. RADIATIVE CAPTURE EXPERIMENTS. Rolfs, C.; Charlesworth, A. M.; Azuma, R. E. (Univ. of Toronto). Nucl. Phys.; A199: No. 2, 257-73 (1973).

Excitation curves for the ^{14}N(α,γ)^{18}F and ^{17}O(p,γ)^{18}F capture reactions were obtained for E_α = 1.0 to 3.2 MeV and E_p = 0.15 to 1.4 MeV, respectively. The known resonances in ^{14}N(α,γ)^{18}F as well as the seven new resonances at E_α = 1765, 2160, 2166, 2374, 2438, 2532 and 2767 keV were studied. The resonance at E_α = 2166 keV corresponds to a new state at E_x = 6108 keV. The twelve known resonances in ^{17}O(p,γ)^{18}F were studied. All these resonances correspond to states in ^{18}F previously observed in other reactions except those at E_p = 587 and 714 keV. The study of these two resonances has confirmed the existence of two new states at E_x = 6164 and 6284 keV. The narrow resonance ($\Gamma \leq$ 3 keV) at E_p = 1269 keV corresponds to a new state at E_x = 6803 keV, compared with a previously reported state at E_x = 6811 keV with Γ = 90 ± 5 keV. Excitation energies, γ-ray decay schemes, resonance widths and strengths, as well as J^π and T assignments are reported for all resonance states. These studies also yielded spectroscopic information on the states below E_x = 5 MeV. This latter information was supplemented by studies which involved the ^{16}O(^{3}He,pγ)^{18}F reaction. (auth)

13422 NUCLEAR STRUCTURE OF ^{18}F. II. LOW-SPIN $(2s,1d)^2$ STATES. Rolfs, C.; Kiesler, W. E.; Azuma, R. E.; Litherland, A. E. (Univ. of Toronto). Nucl. Phys.; A199: No. 2, 274-88(1973).

The 6138 keV state in ^{18}F was studied at the E_p = 561 keV resonance of the ^{17}O(p,γ)^{18}F capture reaction. The resonance strength $\omega\gamma$ together with the angular distribution and $\gamma-\gamma$ angular-correlation data resulted in a J = 0, T = 1 assignment to the resonance state. The parity of the resonance state as well as those for the states at 1701 and 3725 keV were determined to be positive from $\gamma-\gamma$ linear-polarization angular correlations. In addition, a $J^\pi = 1^{(+)}$, T = 0 assignment was found for the 4361 keV state. The lifetimes of the 1701, 3725 and 4361 states were determined from Doppler shift measurements to be 2^{+3}_{-1} ps, 4 ± 2 fs and 27 ± 10 fs, respectively. A discussion of the third $J^\pi = 0^+$, T = 1 states in the mass-18 system is presented. The properties of the states studied in this work are compared with shell-model calculations. (auth)

13423 NUCLEAR STRUCTURE OF ^{18}F. III. THE $K^\pi = 1^+$ ROTATIONAL BAND. Rolfs, C.; Trautvetter, H. P.; Azuma, R. E.; Litherland, A. E. (Univ. of Toronto). Nucl. Phys.; A199: No. 2, 289-305(1973).

The 1701, 2523, 3358, 5298 and 6567 keV states in ^{18}F were studied via the reactions ^{14}N(α,γ)^{18}F, ^{17}O(p,γ)^{18}F and ^{16}O(^{3}He,pγ)^{18}F. These studies combined with previous results yield respective assignments of $J^\pi = 1^+$, 2^+, 3^+, 4^+ and 5^+. Information on lifetimes, branching and multipole mixing ratios is reported. These states are identified as the first five members of a $K^\pi = 1^+$ rotational band of a predominantly 4p-2h nature. A comparison with available model calculations is presented. (auth)

13424 STUDY OF THE ^{11}B(^{3}He,p)^{13}C REACTION AT 12, 10, 8, 6, AND 4 MeV. Wu, R. R. (Univ. of Georgia, Athens); Dangle, R. L.; Duncan, M. M.; (and others). Nucl. Phys.; A199: No. 1, 23-30(1973).

Angular distributions for eight proton groups corresponding to states in ^{13}C have been measured at incident ^{3}He energies of 4, 6, 8, 10, and 12 MeV. These states are p_0(ground state), p_1(3.09), p_2(3.68), p_3(3.85), p_4(6.86), p_7(7.68), p_{10}(9.50), and p_{11}(9.90). The angular distributions have been fitted with DWBA analyses using a zero-range approximation. No radial cut-offs were used. In general the data are reasonably well fit at incident energies of 10 and 12 MeV. (auth)

13425 GAMMA RAYS FOLLOWING NEGATIVE MOON CAPTURE IN MEDIUM Z NUCLEI. Miller, G. H. Williamsburg, VA; Coll. of William and Mary (1972). 250p. University Microfilms Order No. 72-24,058.

Thesis.

Muon capture in the medium Z nuclei ^{12}C, ^{24}Mg, and ^{28}Si has been studied by the observation of γ rays from specific final nuclear states. The measured yields of these transitions are compared to the results of (γ,p), (γ,n), and (e,e') experiments to obtain information on the nuclear structure of the elements involved. The energy distribution of some γ rays in the (A-1, Z-1) nuclei are interpreted in terms of the production mechanism. In all cases, there is good evidence for participation of giant resonance states in muon capture. Several Doppler broadened γ ray transitions in (A, Z-1) nuclei have been observed which are suitable for analysis in terms of a $\gamma-\nu$ correlation. The correlations for these transitions are interpreted in terms of the induced pseudoscalar coupling constant in the muon capture Hamiltonian. The measured yields to states in ^{12}B from muon capture to ^{12}C are also interpreted in terms of the weak interaction coupling constants involved. (Diss. Abstr. Int., B)

13426 ELASTIC SCATTERING OF 46-MeV PROTONS BY ^{12}C, ^{58}Ni, AND ^{60}Ni. Willmes, H. (Univ. of Idaho, Moscow); Richardson, J. R.; Slaus, I.; Verba, J. W. Particles Nucl.; 4: No. 4, 192-206(Oct 1972).

Angular distributions were measured for the elastic scattering of 46-MeV protons by ^{12}C, ^{58}Ni, and ^{60}Ni at laboratory angles from 15 to 150° in steps of 2.5 to 5°. A restricted optical model analysis of the nickel data was performed. The results are in good agreement with energy-dependent parameters for the range from 10 to 60 MeV. (auth)

13427 ENERGY LEVELS OF ^{19}F POPULATED BY THE ^{18}O(d,n)^{19}F REACTION AT 4 MeV. Tamisier, R. (Nantes Univ., France); Ardouin, D.; Ramstein, B.; (and others). J. Phys. (Paris); 33: No. 7, 625-33(Jul 1972). (In French).

The ^{18}O(d,n)^{19}F reaction was studied at 4 MeV. Spectroscopic factors were derived from DWBA calculations. Spins and parities were confirmed for the ground state ($1/2^+$), and for the 0.197-MeV ($5/2^+$), 6.27-MeV ($1/2^+$), 6.79-MeV ($5/2^+$) levels. The following assignments $J^\pi = 1/2^-$, $3/2^-$, $1/2^+$, $1/2^+$ are proposed for the 7.52-MeV, 7.67-MeV and 8.13-MeV states. (France)

13428 GAMMA-RAYS FROM NEUTRON-INDUCED REACTIONS IN NITROGEN. Nystroem, G.; Conde, H.; Lundberg, B.; Stroemberg, L. G. (Foersvarets Forskningsanstalt, Stockholm). Phys. Scr.; 5: No. 4-5, 175-82(1972).

The gamma-ray production cross sections of nitrogen have been measured at three different incident neutron energies, 4.2, 5.9, and 6.9 MeV. The gamma-ray spectrometer was a Ge(Li) detector. Time-of-flight techniques were employed to suppress the background caused by neutron interactions in the Ge(Li)-detector. The efficiency of the gamma-ray spectrometer was measured with calibrated gamma-ray sources and (p,γ) reactions. The primary neutron flux was measured with a proton-recoil telescope. Differential gamma-ray production cross sections at 55° are given. The angular distributions of the gamma-rays were measured at E_n = 6.9 MeV between 40° and 140°. The results were compared with calculated distributions obtained with a statistical compound-nucleus theory. The lifetimes of the six lowest excited states in ^{14}N could be estimated from the observed Doppler shifts in the angular distribution measurement. (auth)

13429 NUCLEAR STRUCTURE OF ^{18}F. IV. NEGATIVE-PARITY STATES. Rolfs, C.; Berka, I.; Azuma, R. E. (Univ. of Toronto). Nucl. Phys.; A199: No. 2, 306-27(1973).

Studies via the ^{16}O(^{3}He,pγ)^{18}F, ^{14}N(α,γ)^{18}F, and ^{17}O(P,γ)^{18}F reactions have resulted in new J^π assignments for 11 states of negative parity: E_x (keV) (J^π) = 3791(3^-), 4226($2^{(-)}$), 4398(4^-), 4860-($1^{(-)}$), 5502($3^{(-)}$), 5785(2^-), 6097(4^-), 6108($1^{(-)}$, $2^{(-)}$, $3^{(-)}$), 6241(3^-, T = 1), 6643(2^-, T = 1) and 6878($3^{(-)}$, 4^-). The 6241 keV state is probably isospin mixed. New information for 5 states of positive

parity has also been obtained: E_x(keV) (J^π) = 3838(2^+), 4115(3^+), 4652(4^+, T = 1), 4753((0^+), T = 1) and 4964(2^+, T = 1). Mean lives, branching and mixing ratios are reported for all states. The results for the negative-parity states are discussed in the framework of the various models available. The states at E_x = 1080(0^-), 2100(2^-), and 4398(4^-) keV are interpreted as the first three members of a $K^\pi = 0^-$ rotational band. (auth)

13430 NUCLEAR STRUCTURE OF ^{18}F. V. A FURTHER STUDY AND SUMMARY OF LOW-LYING $(2s,1d)^2$ STATES. Rolfs, C.; Berka, I.; Trautvetter, H. P.; Azuma, R. E. (Univ. of Toronto). Nucl. Phys.; A199: No. 2, 328-50(1973).

The 6164, 6284, 6310, 6383, 6480, 6777, and 6803 keV states were studied via the capture reactions ^{14}N(α,γ)^{18}F and ^{17}O(p,γ)^{18}F. These studies yield respective assignments of $J^\pi(T) = 3^+(1)$, $2^+(0+1)$, $3^+(0)$, $2^+(0+1)$, $3^+(0)$, $4^+(0)$ and 1^+, 2 or 3(0). Information on radiative widths, branching and multipole mixing ratios is reported. The 6164 and 6777 keV states are well described theoretically by simple $(d_{5/2}s_{1/2})_{3+}$ and $(d_{5/2}d_{5/2})_{4+}$ configurations, respectively. The 2^+ states at 6284 and 6383 keV are mixed in isospin. A comparison of the observed properties with the available model calculations is presented for the above states as well as for some low-lying positive-parity states. (auth)

13431 ANALOG AND CONFIGURATION STATES IN ^{49}Sc ($J^\pi = 3/2^-$ and $1/2^-$) AND THE LOW-LYING LEVEL STRUCTURE IN ^{48}Sc. Bloom, S. D. (Univ. of California, Livermore); McCrory, J. B.; Moszkowski, S. A. Nucl. Phys.; A199: No. 2, 369-85(1973).

The $J^\pi = 3/2^-$ and $1/2^-$ states in ^{49}Sc generated by the configurations $[(1f_{7/2})^8\ (2p_{3/2,1/2})]$ are discussed. Excitation energies, M1 transitions, and E2 transitions among the seven $3/2^-$ and five $1/2^-$ levels, including the $3/2^-$ analog state at E_x = 11.56 MeV and a putative excited analog $1/2^-$ state at ≈13.6 MeV, were calculated and compared with experiment where possible. The β-decay of ^{49}Ca to the $3/2^-$ level at 3.08 MeV and the (presumably) $1/2^-$ level at 4.49 MeV (the lowest-lying $3/2^-$ and $1/2^-$ levels) were also calculated. Two interactions were used, the well-known Kuo-Brown (KB) force and a new interaction which we call the PMM force, the latter being derived mainly from direct-reaction cross sections of nucleons on various nuclei. Both KB and PMM interactions lead to cancellations which cut down both the β-decay of ^{49}Ca and the M1 decay of the A-state to the lowest-lying $3/2^-$ and $1/2^-$ states, as observed experimentally. In addition, strong M1 decays to several $3/2^-$ and $1/2^-$ levels with excitations of 7–11 MeV are predicted, as is observed experimentally. The E2 decays of all the predicted $3/2^-$ states to the $7/2^-$ ground state were also calculated. In the case of the E2 decay of the A($3/2^-$) state, comparison with experiment is hampered by the role of fine structure; experiment is weaker than theory by a factor of ≈50. The $(1f_{7/2})^8$ group of levels in ^{48}Sc were also calculated ($J^\pi = 0^+ \rightarrow 7^+$). The PMM force gave excellent agreement with recent experimental results while the KB force gave relatively poor agreement, as might be expected from the severe truncation of the shell-model basis. The suggestion is that the phenomenological basis of the PMM force corresponds physically to the $(1f_{7/2})^8$ space of ^{48}Sc as well as the $(1f_{7/2})^8$ ($2p_{3/2}$ or $2p_{1/2}$) space of ^{49}Sc. (auth)

13432 LEVELS IN ^{13}N NEAR E_x = 12 MeV FROM p VECTOR + ^{12}C SCATTERING. Meyer, H. O. (Univ. of Wisconsin, Madison); Plattner, G. R. Nucl. Phys.; A199: No. 2, 413-23(1973).

The level structure of ^{13}N was studied via elastic and inelastic scattering of polarized protons from ^{12}C. Complete angular distributions of the analyzing power and of the differential cross section were measured at 17 proton lab energies between 9.5 and 11.5 MeV. A phase-shift analysis of the elastic-scattering data has revealed the existence of T = ½ states in ^{13}N with the parameters $J^\pi(E_x)$: $5/2^+$(11.49 MeV), $5/2^-$(11.71 MeV), $3/2^+$(11.75 MeV), $3/2^-$(11.75 MeV), $1/2^+$ (11.86 MeV), and $7/2^-$(12.14 MeV). (auth)

13433 SPECTRA AND ABSOLUTE YIELDS OF NEUTRONS FROM THICK TARGETS BOMBARDED BY 23.2 MeV DEUTERONS. Daruga, V. K.; Matusevich, E. S.; Narziev, Kh. At. Energ. (USSR); 33: No. 5, 934-6(Nov 1972). (In Russian).

A study was made of the energy distributions and absolute yields of neutrons from thick targets of Be, Al, Ni, Nb, Ag, Ta, and Pb of natural isotopic compositions. The deuteron beam originated in a 1.5-m cyclotron and possessed an average energy of 23.2 MeV. The energy spectra (above 0.5 MeV) were measured with a single crystal of stilbene in a spectrometer at angles of 0, 45, 90, and 135°. The range of Z used permitted a nearly smooth curve to be drawn representing neutron yield as a function of atomic number. (K.S.W.)

13434 INTERACTIONS OF 17 TO 29 MeV PROTONS WITH BERYLLIUM. Montague, D. G. (Univ. of California, Los Angeles); Cole, R. K.; Lewis, P. S.; Waddell, C. N.; Hendrie, D. L. Nucl. Phys.; A199: No. 3, 433-56(1973).

Differential cross sections for the elastic scattering of 17.0, 21.0, 25.0, and 29.1 MeV protons by ^{9}Be are presented. Optical-model analyses of these data have yielded potential depth parameters which vary smoothly with energy for a consistent set of geometrical parameters. Inelastic differential cross sections to the 2.43 MeV and 3.03 MeV states of ^{9}Be are also given. The differential cross sections of the ^{9}Be(p,d)^{8}Be reactions leading to the ground and the 2.90 MeV states of ^{8}Be are shown and compared to distorted-wave single-nucleon transfer calculations. (auth)

13435 PROTON TOTAL REACTION CROSS SECTIONS OF BERYLLIUM FROM 16 TO 28 MeV. Montague, D. G.; Cole, R. K.; Makino, M.; Waddell, C. N. (Univ. of California, Los Angeles). Nucl. Phys.; A199: No. 3, 457-62(1973).

The proton total reaction cross sections of ^{9}Be are presented for eight energies between 16.2 and 28.0 MeV. The results are in good agreement with optical-model predictions from analyses of elastic scattering data. The results are also compared to predictions of the opaque-nucleus model which represents the reaction cross sections of medium and heavy weight nuclei rather well. This simple model correctly predicts the observed energy dependence but requires a larger radius parameter than is needed for the heavier nuclei. (auth)

13436 ^{7}Li(n,p)^{7}He REACTION. Lindsay, R. H.; Toews, William; Veit, J. J. (Western Washington State Coll., Bellingham). Nucl. Phys.; A199: No. 3, 513-16(1973).

The proton energy spectra at several angles from the ^{7}Li(n,p)^{7}He reaction confirm earlier studies using the ^{7}Li(t,^{3}He)^{7}He reaction where ^{7}He was found to be unbound to neutron emission by 420 ± 60 keV. The cross section at $\theta_{cm} = 0°$ is 0.40 ± 0.1 mb/sr, and at $\theta_{cm} = 30°$ a value of 0.35 ± 0.10 mb/sr is obtained. Also observed in this study are the deuteron, triton and ^{6}He spectra from the 14.8 MeV neutron bombardment of ^{7}Li. (auth)

13437 COHERENT GENERATION OF THE $2\pi^-\pi^+$ SYSTEM ON NUCLEI. Vasil'kova, A. D.; Gornov, M. G.; Kirillov-Ugryumov, V. G.; (and others) (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 261-4 (5 Oct 1972).

New data were obtained on the coherent generation of a triad of uncorrelated pions ($\pi^+2\pi^-$) on carbon, fluorine, and chlorine by a π^- meson at ~3.9 GeV/c. Mass distributions of the $\pi^+2\pi^-$ and $\pi^+\pi^-$ systems are presented. An analysis of the angular distributions and cross sections showed that the contribution of the bound states of three pions to the coherent process is small. It is suggested that the process can be represented as a stripping of virtual pions from the primary particle by the field of the nucleus. (L.B.S.)

13438 POSSIBLE DECAY IN FLIGHT OF (^{6}Li$_\Lambda$). Mondal, A. S.; Basak, A. K.; Kasim, M. M.; Husain, A. (Rajshahi Univ., India). Lett. Nuovo Cim.; 5: No. 17, 1057-61(23 Dec 1972).

In a systematic search for rare hypernuclear species in nuclear emulsion exposed to a separated beam of 3.0-GeV/c K^- mesons at CERN proton synchrotron an event was observed whose best interpretation is in terms of (^{6}Li$_\Lambda$)* with the decay mode (^{6}Li$_\Lambda$)* → p + ^{5}He$_\Lambda$, with a binding energy, B_Λ = (4.17 ± 0.40) MeV. (L.B.S.)

13439 RADIATIVE CAPTURE OF ALPHA PARTICLES TO STATES IN ^{18}F. Charlesworth, A. M. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa. Thesis.

The nucleus ^{18}F has been studied using the radiative capture reaction ^{14}N(α,γ)^{18}F. A large, high-resolution Ge(Li) detector was used to study the complex decay modes at three prominent resonances in the bombarding particle energy range 1.5 to 2.5 MeV. In addition, a partial study was made of four other resonances in the energy range 1.0 to 3.0 MeV. To carry out these measurements it was necessary to develop a directly-cooled target suitable for bombardment with up to 200 μA of alpha particles and to devise an efficient cold shroud capable of preventing the accumulation of carbon on the titanium nitride targets. Branching ratios, mixing ratios and relative resonance yields of the decay gamma rays have been measured and assignments of spin, parity and isobaric spin for four resonance levels have been deduced. Evidence is presented in support of the suggestion that the amplitude of an expected $J^\pi = 1^-$, T = 1 state in ^{18}F is split between the 5606-keV and 5674-keV states. Similar evidence is presented which casts doubt on the suggestion that the amplitude of an expected $J^\pi = 3^{(-)}$, T = 1 state in ^{18}F is split between the 6098-keV and 6245-keV levels. This evidence supports assignments of $J^\pi = 3^-$, T = 0 + 1 for the 6245-keV state and $J^\pi = 4^-$, T = 0 for the 6098-keV state. In addi-

tion, arguments are presented in favor of the spin assignments of J = 3 for the 3790-keV state, J = 2 for the 4231-keV state and J = 2, 4 for the 4400-keV state in ^{18}F. The experimental results for the $J^{\pi} = 1^{-}$, mixed isospin doublet are compared with the theoretical predictions of a model based on two isobaric spin components. (Diss. Abstr. Int., B)

13440 ABSOLUTE DIFFERENTIAL CROSS-SECTION OF THE $^{9}Be(d,p)^{10}Be$ AND $^{10}B(d,p)^{11}B$ REACTIONS AT DEUTERON ENERGY $E_d \leq 2.5$ MeV. Arena, N. (Univ., Catania, Italy); Calvi, G.; Cavallaro, S.; (and others). Lett. Nuovo Cim.; 5: No. 13, 879-82 (25 Nov 1972).

Measurements were made of the absolute differential cross sections at 30, 60, 90, and 150° for $E_d = 0.75$ to 2.25 MeV for the $^{9}Be(d,p)^{10}Be$ reaction and for $E_d = 0.70$ to 2.50 MeV for the $^{10}B(d,p)^{11}B$ reaction, in 50 keV steps. (WDM)

13441 SPECTROSCOPY OF LIGHT NUCLEI BY LOW ENERGY (<70 MeV) INELASTIC ELECTRON SCATTERING. Theissen, Horst (Technische Hochschule, Darmstadt, Ger.). Springer Tracts Mod. Phys.; 65: 1-57(1972).

Some spectroscopic studies of light nuclei using low-energy electron scattering are surveyed. Experimental facilities and methods are reviewed as well as methods of data reduction and analysis. Individual transition types are discussed and some examples presented. An extensive list of references is provided. (JWR)

13442 MEASUREMENTS OF SPINS AND PARITIES IN THE $^{16}O(p,\gamma)^{17}F$ AND $^{16}O(p,p'\gamma)^{16}O$ REACTIONS. Abraham, D. R. Manhattan, KS; Kansas State Univ. (1972). 79p. University Microfilms Order No. 72-28,824.

Thesis.

Angular distributions for gamma rays from both (p,γ) and $(p,p'\gamma)$ reactions on ^{16}O were studied. A confirmation of the $5/2^{-}$ spin assignment for the 3.47 MeV state was made. The four resonances at 6.8, 7.2, 7.4, and 7.9 MeV proton bombarding energy were studied by observing the gamma rays from $(p,p'\gamma)$ reactions. Analysis of the results suggests a spin of $5/2$ for the 6.8 MeV resonance and $5/2$, $7/2$, or $9/2$ for the 7.2 MeV resonance, confirms the assignment of $7/2^{-}$ for the 7.4 MeV resonance, and suggests a spin of $7/2^{+}$ for the 7.9 MeV resonance. (Diss. Abstr. Int., B)

13443 ABSOLUTE CROSS SECTION FOR PRODUCING ^{11}C FROM CARBON BY 270-MeV/NUCLEON ^{14}N IONS. Skoski, L.; Merker, M.; Shen, B. S. P. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 30: No. 2, 51-4(8 Jan 1973).

The cross section for producing ^{11}C from carbon irradiated by 270-MeV/nucleon ^{14}N has been found to be 90.0 ± 4.6 mb. The measurement was made using internal counting in plastic scintillators of three different thicknesses; the nitrogen beam was monitored by nuclear emulsions. (auth)

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Refer also to abstracts 11702, 13399, 13425, 13433, and 13597.

13444 (ANU-P-556) 5.80 MeV STATE OF ^{32}S. Gardner, P. R.; Moss, C. E.; Spear, R. H.; Carlson, L. E. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 21p. Dep. NTIS (U. S. Sales Only).

Studies of the reaction $^{29}Si(\alpha,n\gamma)^{32}S$ indicate that the 5.80-MeV state of ^{32}S has an excitation energy of 5798.2 ± 1.0 keV, a mean lifetime of 14 ± 7 fs, and a spin of 1. Particle–gamma coincidence studies of the reaction $^{32}S(p,p'\gamma)^{32}S$ indicate that the state decays 100% to the 0^{+} ground-state, with all other possible transitions having intensities ≲2% of the ground state transition. The properties of the state are discussed in terms of the coupled quadrupole–octupole vibrator model. (auth)

13445 (ANU-P-561) GAMMA-RAY DECAY SCHEMES OF LEVELS AT INTERMEDIATE ENERGIES IN ^{32}S. Moss, C. E.; Spear, R. H.; Ahmad, F.; Baxter, A. M.; Carlson, L. E.; Gardner, P. R. (Australian National Univ., Canberra. Inst. of Advanced Studies). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The reaction $^{32}S(p,p'\gamma)^{32}S$ was studied with a 12.7 cm × 10.2 cm NaI(Tl) gamma-ray detector in conjunction with a 61 cm double-focusing magnetic spectrometer to determine the gamma-ray decay schemes of all known levels in ^{32}S between the excitation energies of 5.40 and 7.15 MeV. (auth)

13446 (CONF-720309–, pp 331-41) STUDY OF (^{3}He,n) REACTIONS ON NUCLEI IN THE 2s-1d AND 1f-2p SHELLS. Bass, R.; Friedland, U.; Nann, H.; Patscher, W.; Reiter, A. (Univ., Frankfurt am Main). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The (^{3}He,n) reaction on ^{28}Si, ^{29}Si, ^{30}Si, ^{32}S, ^{35}Cl, ^{37}Cl, ^{48}Ti, ^{52}Cr, ^{54}Fe, and ^{56}Fe was studied at an incident energy of 14 MeV. Angular distributions were measured up to 120° in 5° steps with a resolution of about 10°. The results were compared with DWBA calculations. (J.W.R.)

13447 (CONF-720309–, pp 342-8) TWO NUCLEON TRANSFER TO 1^{+} STATES IN ^{32}P. Betts, R. R. (Univ. of Pennsylvania, Philadelphia); Fortune, H. T.; Pullen, D. J.; Wildenthal, B. H. 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

A multiangle spectrograph was used to study the $^{30}Si(^{3}He,p)$ reaction at a bombarding energy of 18 MeV. Angular distributions were measured and analyzed for $0^{+} \rightarrow 1^{+}$ transitions. The DWUCK code was used in the calculations. (J.W.R.)

13448 (CONF-720309–, pp 372-80) STUDY OF (^{3}He,p) REACTIONS ON NUCLEI IN THE 2s-1d SHELL. Nann, H. (Univ., Frankfurt am Main); Bass, R.; Armbruster, L.; (and others). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The $^{27}Al(^{3}He,p)$ reaction was studied at an incident energy up to 14 MeV and the $^{32}S(^{3}He,p)$ reaction was studied at 24 MeV. The experimental angular distributions for both reactions were compared with calculations made using shell model wave functions. (J.W.R.)

13449 (CONF-720309–, pp 381-8) (p,t) REACTION ON ^{24}Mg AND ^{26}Mg. Nolen, J. A.; Benenson, W.; Larson, Duane, Proctor, I. D.; Wildenthal, B. H. (Michigan State Univ., East Lansing). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The $^{24}Mg(p,t)^{22}Mg$ and $^{26}Mg(p,t)^{24}Mg$ reactions have been studied at proton energies of 42.0 and 40.0 MeV respectively. Angular distributions were obtained for the ground and first excited states of ^{22}Mg and for the ground and five lowest excited states in ^{24}Mg. Measured reaction strengths are compared to predictions of the DWBA made with shell-model wave functions. (auth)

13450 (COO-2130-29) ATOMIC AND NUCLEAR PHYSICS STUDIES WITH ACCELERATORS. Leachman, R. B. (Kansas State Univ., Manhattan (USA). Nuclear Labs.). Apr 1972. Contract AT(11-1)-2130. 125p. Dep. NTIS.

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13451 (UCRL-Trans-10655) PRECISION MEASUREMENT OF THE ^{27}Al (n,α) CROSS-SECTION FOR 14.43 MeV NEUTRONS. Vonach, H.; Hille, M.; Stengl, G.; Breunlich, W.; Werner, E. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Z. Phys.; 237: 155-79(1970). 36p. Dep. NTIS.

A precision measurement of the ^{27}Al(n,α)^{24}Na cross section for 14.43 MeV was performed. Aluminum samples were irradiated in an accurately known neutron flux determined by the associated particle method. The induced ^{24}Na activity was measured with a scintillation detector accurately calibrated by means of ^{24}Na standards by the β-γ-coincidence method. By carefully minimizing all sources of systematic errors the authors obtained an over-all accuracy of 0.7% at 99.5 (3σ) confidence level. The measurements result in a cross section of 117.0 mb for ^{27}Al(n,α)^{24}Na for neutrons with an average energy of 14.43 MeV and an energy width of approximately 0.2 MeV. (auth)

13452 EXCITED LEVELS OF THE ^{30}P NUCLEUS AT 7.5 TO 8.5 MeV. Kostin, V. Ya.; Kopanets, E. G.; L'vov, A. N.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 495-8(Mar 1972). (In Russian).

The excitation function for the reaction ^{29}Si(p,γ)^{30}P was measured at E_p = 2,000 to 3,000 keV. The decay scheme was obtained, and 18 resonances were noted. Isospin mixing was demonstrated for the 8.010-MeV level (E_p = 2.496 MeV) in the nucleus ^{30}P. It is suggested that the 8,216-keV level (E_p = 2.709 MeV) may be an isobaric analog state. (2 figures, 1 table). (tr-auth)

13453 STUDY OF LEVELS IN ^{21}Ne. Dubois, J.; Christiansson, J. E.; Jarneborn, L.; (and others) (Chalmers Univ. of Tech., Goteborg). Phys. Scr.; 5: No. 4-5, 169-74(1972).

A versatile facility for studying nuclear reaction has been built. The ^{20}Ne(d,pγ)^{21}Ne reaction has been studied using particle-gamma and gamma-gamma coincidence technique. Surface barrier solid state detectors and Ge(Li) detectors were used together with a multi-dimensional storage of data in a PDP-15 on-line computer. Energies and gamma radiation branching ratios of levels in ^{21}Ne up to 4.7 MeV have been measured. Levels in ^{21}Ne are discussed in terms of modern shell model calculations and the Nilsson strong-coupling model. (auth)

13454 SEARCH FOR A MISSING $J^\pi = 3/2^+$ LEVEL IN ^{21}Na. Dubois, J.; Odelius, H.; Berglund, S. O. (Chalmers Univ. of Tech., Goteborg). Phys. Scr.; 5: No. 4-5, 163-8(1972).

The ^{20}Ne(^{3}He,d)^{21}Na reaction has been studied at 16-MeV bombarding energy. The emitted deuterons have been analyzed in a double-focusing magnet. Levels in ^{21}Na were deduced. Furthermore the ^{20}Ne(p,γ)^{21}Na reaction has been investigated using a 44 cm^3 Ge(Li) detector. Gamma-ray branching ratios and lifetimes have been measured at the 1169, 1311, and 1504 keV resonances. The experimental information is discussed in terms of the Nilsson strong-coupling model and recent shell model calculations. (auth)

13455 ELASTIC NEUTRON TRANSFER IN THE SCATTERING OF ^{28}Si ON ^{29}Si. Hildenbrand, K. D.; Bock, R.; Bohlen, H. G.; (and others) (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.: 42B: No. 4, 425-7(25 Dec 1972).

Angular distributions from the elastic scattering of ^{28}Si by ^{29}Si were measured at 65 and 70 MeV (lab) with a time-of-flight spectrometer. The structure of the angular distributions is well understood by the assumption of an interference between the elastic scattering and the elastic transfer amplitudes. A spectroscopic factor of S^2 = 0.43 was deduced for the $2s_{\frac{1}{2}}$ neutron in ^{29}Si. (auth)

13456 BETA DECAY OF ^{23}Ne. Christiansson, J. E.; Dubois, J.; Jarneborn, L. (Chalmers Univ. of Tech., Goteborg). Phys. Scr.; 5: No. 4-5, 159-62(1972).

The decay of ^{23}Ne to levels in ^{23}Na has been studied by measuring the gamma radiation following the β decay of the ^{23}Ne nuclei produced in the ^{22}Ne(d,p)^{23}Ne reaction. New levels in ^{23}Na reported by Lancman et al. could not be confirmed. The ft-values have been calculated using the Nilsson model and mixed states from Rotation Particle Coupling calculations including pairing effects in the matrix element. Reasonable agreement with the experimental result is obtained. (auth)

13457 EVIDENCE FROM INELASTIC PROTON SCATTERING FOR A GIANT QUADRUPOLE VIBRATION IN SPHERICAL NUCLEI. Lewis, M. B.; Bertrand, F. E. (Oak Ridge National Lab., TN). Nucl. Phys.; A196: No. 2, 337-46(1972).

A systematic study of inelastic proton continuum spectra produced at small angles by bombardment of ^{27}Al, ^{54}Fe, ^{120}Sn and ^{209}Bi with 62 MeV protons suggests the existence of a collective region in the continuum with properties of a giant quadrupole vibration. (auth)

13458 LIFETIMES IN ^{22}Ne, ^{22}Na, ^{30}Si, ^{30}P, AND ^{35}Cl USING THE RECOIL-DISTANCE METHOD. Anyas-Weiss, N.; Griffiths, R.; Jelley, N. A.; (and others) (Nuclear Physics Lab., Oxford). Nucl. Phys.; A201: No. 3, 513-533(1973).

Levels in ^{22}Ne, ^{22}Na, ^{30}Si, ^{30}P and ^{35}Cl were excited in the following reactions: ^{19}F(α,p)^{22}Ne, ^{19}F(α,n)^{22}Na, ^{27}Al(α,p)^{30}Si, ^{27}Al(α,n)^{30}P and ^{32}S(α,p)^{35}Cl. The recoil-distance method was used to measure lifetimes of excited states in the residual nuclei. The measured values are: ^{22}Ne(1275) = 5.40 ± 0.40 ps, ^{22}Na(1984) = 2.40 ± 0.25 ps, ^{30}Si(3788) = 6.8 ± 2.0 ps, ^{30}P(709) = 54 ± 5 ps and ^{35}Cl(3163) = 53 ± 6 ps. These values are compared to previous measurements by the recoil-distance technique, as well as by different techniques, and are also compared to theoretical predictions. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 11702, 12233, 13395, 13426, 13446, 13450, 13457, 13470, 13471, 13479, and 13514.

13459 (ANU-P-554) ^{36}Ar(α,γ_0)^{40}Ca REACTION AT EXCITATION ENERGIES IN THE REGION OF THE GIANT DIPOLE RESONANCE. Watson, R. B.; Branford, D.; Black, J. L.; Caelli, W. J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 24p. Dep. NTIS (U. S. Sales Only).

The differential cross section for the ^{36}Ar(α,γ_0)^{40}Ca reaction was measured at 90° to the beam direction in 125 keV, 50 keV, and 50 keV intervals over the bombarding energy ranges 6 to 17 MeV, 6.54 to 8.81 MeV, and 11.67 to 13.65 MeV, respectively. Gamma-ray angular distributions were measured at eighteen bombarding energies. The results indicate that the reaction proceeds through isolated 1^- levels and to a lesser extent 2^+ levels. Excitation energies and partial decay widths for the 1^- levels are presented. From a comparison of the ^{36}Ar(α,γ_0)^{40}Ca, ^{39}K(p,γ_0)^{40}Ca and ^{40}Ca(γ,no)^{39}Ca excitation functions, it is shown that the α-capture reaction most probably leads to exciting the predominantly T = 1 giant dipole resonance states through a T = 0 isospin impurity. The result presented, that the α-reduced widths decrease by a factor of forty over the excitation energy region considered, is discussed with regard to variations in the degree of isospin mixing with energy and a shell-model calculation. (auth)

13460 (CONF-720309-, pp 349-56) ^{48}Ca(p,t)^{46}Ca REACTION AT E_p = 39 MeV. Crawley, G. M. (Michigan State Univ., East Lansing); Miller, P. S.; Igo, G. J.; Kulleck, J. 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Triton spectra and angular distributions for the ^{48}Ca(p,t) reaction were measured at E_p = 39 MeV. The data were compared with distorted-wave calculations and a reasonable agreement was found. The results were also compared with (t,p) reactions to the same final states. (J.W.R.)

13461 (COO-1764-167) NON-LOCAL AND MAJORANA-EXCHANGE TERMS IN THE OPTICAL MODEL. Greenlees, G. W.; Makofske, W.; Tang, Y. C.; Thompson, D. R. (Minnesota Univ., Minneapolis. School of Physics). 1972. Contract AT(11-1)-1265. 23p. Dep. NTIS.

The suggestion that nonlocal terms arising from the effects of antisymmetrization in light systems should be present in heavier systems is examined. The introduction of one such term into the optical potential for proton-nucleus scattering produces significant effects at backward angles. It is shown that these nonlocal effects can be represented almost exactly by the introduction of

a Majorana component into the real central potential. The results are applied in an analysis of 30-MeV proton-elastic-scattering data from ^{40}Ca. (auth)

13462 ROTON AND SHELL-MODEL 0^+ STATES FOR A (4p–4n) SYSTEM IN THE $f_{7/2}$ SHELL. Richert, J. (Centre de Recherches Nucleaires, Strasbourg). Phys. Lett.; 42B: No. 4, 395-8(25 Dec 1972).

The Hamiltonian of a (4p–4n) system in the $f_{7/2}$ shell is diagonalized by using the roton model of quartets. The spectra and wave functions of 0^+ states are compared with those given by the shell model. (auth)

13463 MULTI-CHANNEL STUDY OF FINE STRUCTURE OF AN ANALOGUE STATE IN ^{59}Co. Peters, W. C. (Duke Univ., Durham, NC); Bilpuch, E. G.; Mitchell, G. E. Phys. Lett.; 42B: No. 4, 422-4(25 Dec 1972).

The fine structure of the analog of the ground state of ^{59}Fe was studied by the ^{58}Fe(p,p), (p,p'), and (p,γ) reactions. The fine-structure widths for these three channels are correlated. Evidence for correlations in the decay of fragmented analog states in the 1f–2p shell is summarized and interpreted. (auth)

13464 HIGH-RESOLUTION PROTON SCATTERING ON ^{46}Ti. Prochnow, N. H. (Duke Univ., Durham, NC); Newson, H. W.; Bilpuch, E. G.; Mitchell, G. E. Nucl. Phys.; A199: No. 3, 571-92(1973).

Differential cross sections were measured for ^{46}Ti(p,p) and ^{46}Ti(p,p$_1$) at four angles between E_p = 1.5 and 3.1 MeV, with an over-all energy resolution of about 300 eV. Spins, parities, total and partial widths were extracted for 144 resonances. Six analog states were identified. The s-wave states have expected spacing and width distributions, while the $p_{3/2}$ states behave anomalously. The $s_{1/2}$, $p_{3/2}$ and $p_{1/2}$ strength functions were determined. (auth)

13465 VIRTUAL NUCLEAR EXCITATION CORRECTIONS TO ELASTIC ELECTRON SCATTERING FROM ^{40}Ca. Lin, W. F. (Stanford Univ., CA). Nucl. Phys.; A199: No. 1, 14-22(1973).

The virtual nuclear excitation (dispersion) corrections to elastic electron scattering from ^{40}Ca have been calculated in second-order Born approximation. A model that can reproduce the whole inelastic response surface is employed for the nuclear currents that enter. The dispersion correction, expressed relative to the first Born result, is dependent only on the nuclear Fermi momentum. When the intermediate nuclear states are summed (without using closure) through the quasi-elastic scattering region, the corrections are found to be small (about 3%). However, these should be included in analyzing future data with better experimental accuracy. For the first time, the effect of isobar excitation on the dispersion correction has been examined; because of the questionable validity of the approximations in this case, no definite conclusion can be drawn. (auth)

13466 OPTICAL POTENTIAL OF ^{58}Ni FOR LOW-ENERGY DEUTERONS FROM THE SUB-COULOMB (d,n) REACTION. Bommer, J.; Efken, B.; Fuchs, H.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A199: No. 1, 121-8(1973).

The ^{58}Ni(d,n) reaction to the four lowest ^{59}Cu states has been investigated with the time-of-flight technique at 4.0, 4.5, 5.0, 6.25 and 7.0 MeV bombarding energy. DWBA calculations were performed in which the deuteron potential parameters were varied until optimum fits to the measured differential cross sections were obtained. The evaluated deuteron real-well depth does not depend strongly on energy, in contrast to the result of a deuteron elastic-scattering analysis. (auth)

13467 STUDY OF THE (d,α) REACTIONS ON THE EVEN TITANIUM ISOTOPES. Wallen, R. A. Minneapolis; Univ. of Minnesota (1972). 180p. University Microfilms Order No. 72-27,847.

Thesis.

Differential cross sections are measured for the (d,α) reaction at 19 MeV from the even-even titanium isotopes to states with up to 4 MeV of excitation in the residual nuclei. The data is compared with DWBA calculations, an empirical model, and the results of other experiments leading to the same final nuclei. The comparisons led to spin and parity assignments or confirmed previous assignments for more than 50 levels in the nuclei investigated. The integrated cross sections for levels believed to be excited by the pick-up of two ($1f_{7/2}$) nucleons are compared with the integrated cross sections predicted by a simple $(1f_{7/2})^n$ shell model calculation using MBZ' wave functions. Excellent agreement between experiment and theory was found for 7^+ levels in each of the nuclei studied. Theory consistently underestimated the integrated cross sections for the other $(1f_{7/2})^n$ states. In addition, a number of negative parity states are very strongly excited. Some of these states are not seen in single nucleon transfer reactions. Also, several instances are observed in which the experimental transitions proceed in violation of the standard selection rules. (Diss. Abstr. Int., B)

13468 (p,t) REACTIONS ON ^{45}Sc AND ^{44}Ca AND THE WEAK-COUPLING CORE-EXCITATION MODEL. Seth, K. K. (Northwestern Univ., Evanston, IL); Ohnuma, H.; Suehiro, T.; Yamada, S.; Takeda, S. Phys. Rev. Lett.; 30: No. 4, 132-5(22 Jan 1973).

From a study of the (p,t) reaction on ^{45}Sc and ^{44}Ca, J^π of the 1.41-MeV state in ^{43}Sc is inferred to be $^7/_2^-$. It is found that both the absolute cross sections and angular distribution shapes for this transition are almost identical with those for the transition to the 1.84-MeV 0_2^+ state in ^{42}Ca (as are the corresponding ground-state transitions). It is suggested that the 1.41-MeV state in ^{43}Sc consists primarily of the 0_2^+ excited state of the ^{42}Ca core with an $f_{7/2}$ proton weakly coupled to it, just as ^{43}Sc(g.s.) consists mainly of ^{42}Ca(g.s.) plus an $f_{7/2}$ proton. (auth)

13469 MEAN LIVES OF STATES IN ^{51}Cr. Szoeghy, I. M.; Forster, J. S.; Ball, G. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys.; A201: No. 3, 433-444(1973).

Mean nuclear lifetimes of 24 levels in ^{51}Cr, below 4.1-MeV excitation, have been measured by the Doppler-shift attenuation method. The ^{48}Ti(α,nγ) reaction was used at bombarding energies of 6.5, 7.5 and 8.5 MeV. Compton suppressed γ-ray spectra were collected with a 44 cm^3 Ge(Li) detector at 0°, 60°, 90° and 120° to the beam. The electromagnetic properties of the low-lying ^{51}Cr levels indicate a rotational structure built on $K^\pi = ^7/_2^-$ and $^1/_2^-$ Nilsson orbits. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 13399, 13426, 13433, 13463, 13488, and 13536.

13470 (KFK–1662) ELASTIC AND INELASTIC SCATTERING OF 104 MeV ALPHA PARTICLES ON $^{58\ 60\ 62\ 64}$Ni. Rebel, H.; Loehken, R.; Schweimer, G. W.; Schatz, G.; Hauser, G. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Aug 1972. 62p. (In German). Dep. NTIS (U. S. Sales Only).

Differential cross sections were measured for the elastic and inelastic scattering of 104-MeV α particles from ^{58,60,62,64}Ni. The experimental results are analyzed in terms of coupled channels on the basis of an anharmonic vibrational model and prove to be quite sensitive to the values of the deformation parameters. For forward angles the 4^+ angular distributions of ^{58,60}Ni are dominated by a L = 4 single excitation mechanism. This is in keeping with the E4-transitions observed in (e,e') scattering. From the 2_1^+- and 3_1^--results transition rates are derived which can be compared to results of electromagnetic methods and of inelastic proton scattering studies. The comparison indicates that the transition rates differ and are generally higher for the proton scattering. Especially in the case of the 3^- states of ^{58,60}Ni the differences are obvious. The elastic cross sections are analyzed both on the basis of the usual phenomenological model and in terms of a semimicroscopic folding model resulting in values of rms-radii for the nuclear matter distribution. (auth)

13471 PHASE ANALYSIS OF PROTON ELASTIC SCATTERING BY NICKEL ISOTOPES. Pucherov, N. N.; Romanovskii, S. V. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 1025-8(Jun 1972). (In Russian).

An electronic computer was utilized for an automatic search for optimum parameters in an analysis of the elastic scattering of protons by isotopes of Ni. Cross section and polarization values were obtained with 6.9-MeV protons, but only cross sections for 5.4-MeV protons. The calculations were limited to s, p, and d waves. (1 figure, 1 table). (tr-auth)

13472 PERTURBATION OF A $\gamma\gamma$ DIRECTIONAL CORRELATION OF ^{75}As IN GASEOUS $H_2{}^{75}$Se SOURCES. Borchert, I.; Schumacher, M.; Smend, F.; Langhoff, H. (Univ., Gottingen, Ger.). Z. Phys.; 256: No. 5, 441-7(1972).

By using gaseous $H_2{}^{75}$Se sources the $\gamma\gamma$ directional correlation of the 121.0–279.5-keV $\gamma\gamma$ cascade of ^{75}As was measured as a function of pressure. The attenuation coefficient G_2 varied between 0.67 and 0.96 for pressures between 0.1 and 200 torr. Since the perturbation of the directional correlation is caused by hyperfine

interaction of the highly charged ion formed after electron capture, the pressure dependence may be understood as being mainly due to changes of the charge states during collisions with neutral molecules. A simple model is proposed yielding a reasonable fit to the experimental data. (3 figures, 1 table) (auth)

13473 STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF ^{74}Ge AND ^{76}Ge. Grissmer, D. W.; Beyer, R.; Scharenberg, R. P.; (and others) (Purdue Univ., Lafayette, IN). Nucl. Phys.; A196: No. 1, 216-24(1972).

The reorientation effect in Coulomb excitation has been used to determine the static quadrupole moments of the first 2^+ states of the nuclei ^{74}Ge and ^{76}Ge. Thin foils of enriched ^{74}Ge and ^{76}Ge were bombarded by 25 MeV ^{16}O ions. The relative excitation probabilities of the first 2^+ states were measured as a function of projectile scattering angle. Particle-γ coincidences were used to identify the inelastic events. The data were analyzed with the aid of the coupled-channel computer program of Winther and De Boer and excitation of the first 2^+ state via the second 2^+ state was included in the analysis. If the interference term due to excitation via the second 2^+ level is positive, such that the excitation probability is increased, then the extracted values of the static quadrupole moment are $Q_{2+} = -0.25 \pm 1.10$ b for ^{74}Ge and $Q_{2+} = -0.15 \pm 0.10$ b for ^{76}Ge. If the interference term is negative then $Q_{2+} = -0.17 \pm 0.10$ b for ^{74}Ge and $Q_{2+} = -0.05 \pm 0.10$ b for ^{76}Ge. (auth)

13474 EXCITATION CURVES FOR THE REACTIONS OF FAST NEUTRONS WITH ZINC. Santry, D. C.; Butler, J. P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 50: No. 20, 2536-48(15 Oct 1972). (AECL-4291).

The activation method was used to measure cross section values from threshold energies up to 20 MeV for the reactions $^{64}Zn(n,p)$ ^{64}Cu, $^{68}Zn(n,\alpha)^{65}Ni$, and $^{70}Zn(n,2n)^{69}Zn^m$. The neutron flux at energies below 5.3 MeV was determined with a calibrated neutron long counter while at higher energies measurements were made relative to the known cross section for the $^{32}S(n,p)^{32}P$ reaction. Effective cross sections for a fission-neutron spectrum calculated from measured excitation curves are 42.3 ± 2.1 mb for the (n,p) reaction, 0.035 ± 0.003 mb for the (n,α) reaction, and 0.45 ± 0.04 mb for the (n,2n) reaction. Factors influencing precise measurements of fast-neutron cross sections are discussed in detail. (auth)

13475 ENERGY-DEPENDENT β-γ CIRCULAR POLARIZATION AND NUCLEAR MATRIX ELEMENTS IN ^{84}Rb. Schweitzer, J. S.; Simms, P. C. (Purdue Univ., Lafayette, IN). Nucl. Phys.; A199: No. 2, 424-32(1973).

The energy-dependent β-γ circular polarization correlation P_γ was measured to restrict the possible nuclear matrix-element solutions which can be used to describe the $2^- - 2^+$ positron transition in ^{84}Rb. The analysis shows that there may be a significant contribution from all six matrix elements. The matrix-element analysis indicates that A_3 is much smaller than A_1 in P_γ. (auth)

13476 UTILIZATION OF 11.4 MeV PHOTONS FROM THE $^{59}Ni(n,\gamma)^{60}Ni$ REACTION FOR SCATTERING EXPERIMENTS. Moreh, R.; Bar-Noy, T. (Nuclear Research Centre-Negev, Beer Sheba, Israel). Nucl. Instrum. Methods; 105: No. 3, 557-60 (1972).

A new reaction, $^{59}Ni(n,\gamma)^{60}Ni$, producing the highest energy of all known useful capture γ rays was utilized for photon scattering experiments in the energy region of the giant dipole resonance. The γ line energies of the ground-state transitions of the $^{59}Ni(n,\gamma)$, $^{61}Ni(n,\gamma)$, and $^{63}Ni(n,\gamma)$ reactions were measured and found to be 11387.5 ± 1.7 keV, 10596.2 ± 3.7 keV, and 9657.4 ± 2.8 keV, respectively. A comparison is made of the intensity of the 11387.5 keV γ line with that obtained from other (n,γ) sources. (3 figures, 2 tables). (auth)

13477 INVESTIGATION OF NEUTRON-PROTON STATES IN ^{90}Y BY THE REACTION $^{89}Y(d,p\gamma)^{90}Y$. Ernst, J. pp 372-84 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13478 INELASTIC INTERACTION FREE PATH OF HIGH-ENERGY NEUTRONS WITH COPPER NUCLEI. Bhattacharyya, D. P. (Presidency Coll., Calcutta); Das, N. C. Ann. Phys. (Leipzig); 28: No. 1, 43-7(1972).

The inelastic interaction free path of cosmic-ray neutrons in copper was estimated by a multiplate cloud chamber operated by coincidence and anticoincidence technique of Geiger counters and found to be 133 ± 24 g/cm² at 37.5 ± 2.1 GeV energy. The collision free path so obtained is in agreement with the expected value calculated after the optical model of the nucleus. (auth)

13479 STUDY OF ^{59}Cu BY MEANS OF $^{58}Ni(d,n)$. Bommer, J.; Fuchs, H.; Grabisch, K.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A199: No. 1, 115-20 (1973).

The reaction $^{58}Ni(d,n)^{59}Cu$ has been studied at 7.0 MeV bombarding energy. Angular distributions of transitions to 16 states in ^{59}Cu have been extracted and analyzed with DWBA to yield absolute spectroscopic strengths. The results are compared to those of other measurements. (auth)

13480 ISOBARIC ANALOGUE RESONANCES IN THE $^{86}Sr(p,p_0)$ REACTION. Meurders, F.; Van Eeghem, W. P. T. M.; Spilling, P. (Technische Hogeschool, Eindhoven, Netherlands). Nucl. Phys.; A196: No. 2, 353-61(1972).

By means of elastic proton scattering on ^{86}Sr at $E_p = 4.5-7.5$ MeV, isobaric analog states of nine bound levels in ^{87}Sr have been studied. Optical-model parameters describing the non-resonant background have been determined. Neutron single-particle spectroscopic factors, calculated in the R-matrix formalism and in the Green function approach, are compared with $^{86}Sr(d,p)$ results. (auth)

13481 HALF-LIFE MEASUREMENTS IN ^{59}Co, ^{141}Pr, AND ^{227}Ac. Garg, R. K.; Chauhan, S. D.; Sanyal, S.; (and others) (Univ. of Delhi). Z. Phys.; 257: No. 2, 124-36(1972).

The half-lives of the 1291.6-keV level in ^{59}Co, 145.43-keV level in ^{141}Pr, and 27.35-keV level in ^{227}Ac were measured using leading-edge and zero-crossover timing techniques. The decay curves analyzed by moments, Laplace transform, and slope methods gave the following half-life values: $T_{\frac{1}{2}}$(1291.6-keV level in ^{59}Co) = (0.538 ± 0.004) ns, $T_{\frac{1}{2}}$(145.43-keV level in ^{141}Pr) = (1.82 ± 0.04) ns, $T_{\frac{1}{2}}$(27.35-keV level in ^{227}Ac) = (41.0 ± 1.1) ns. From the measured half-lives the reduced transition probabilities B(M1) ↓, B(E2) ↓ for gamma transitions de-exciting the above mentioned levels in ^{59}Co and ^{141}Pr were determined and compared with single-particle, intermediate-coupling, and Sorensen estimates. In ^{227}Ac, absolute transition probability for the 27.35-keV transition was determined and compared with single-particle and Nilsson estimates. (4 figures, 6 tables) (auth)

13482 COULOMB EXCITATION OF ^{73}Ge AND THE BOOTSTRAP THEORY OF VIBRATIONS. Salzman, G. C. Eugene, OR; Univ. of Oregon (1972). 179p. University Microfilms Order No. 72-28,185.

Thesis.

The excitation energies of γ-ray decay modes of several low lying states in the nucleus ^{73}Ge have been studied using Coulomb excitation with alpha particles to test the predictions of the Bootstrap Theory of Vibrations. Thick target γ-ray yields were measured giving partial reduced upward transition probabilities associated with the levels indicated as follows: 68.6 keV (0.20), 499.1 keV (0.08), 485.9 keV (0.001), 554.5 keV (0.003), and 825.6 keV (0.08). Angular distributions of the deexcitation γ-rays from the Coulomb excited levels were measured and various spin possibilities for each level were eliminated by χ^2 techniques. The following spin-parity assignments are consistent with the γ-ray angular distribution measurements: 68.6 keV ($\frac{1}{2}^+$, $\frac{3}{2}^+$, $\frac{11}{2}^+$), 499.1 keV ($\frac{1}{2}^+$, $\frac{3}{2}^+$), 485.9 keV or 554.5 keV ($\frac{1}{2}^+$, $\frac{3}{2}^+$), and 825.6 keV ($\frac{1}{2}^+$, $\frac{13}{2}^+$). Branching ratios were measured for each level and multipole mixing ratios were extracted from the γ-ray angular distribution measurements. The results tend to support the predictions of the Bootstrap Theory. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 12048, 12243, 12442, 13395, 13399, 13433, 13450, 13457, 13477, 13481, 13536, and 13596.

13483 (BMBW-FBK-72-15) ANNUAL REPORT, 1971. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Aug 1972. 163p. (In German). Dep. NTIS (U. S. Sales Only).

The report is composed of the following parts: performance of the TRIGA reactor Mainz; rapid chemical separations and detection of short-lived nuclides (rapid separation of technetium, ruthenium, and actinium from fission products; rapid volatilization of fission products from uranium(IV) fluoride; separation procedure for platinum metals; detection of neutron rich nuclides of arsenic, yttrium, zirconium, niobium, molybdenum, and actinium; systematics of the neutron emission probabilities of delayed

neutron emitters); nuclear spectroscopy (γ-ray spectroscopy of ^{82a,b}As, ^{84}As, ^{93}Sr, ^{94}Sr, ^{95}Sr, ^{107}Ru, ^{150m}1,^{m}2,^{g}Pm, ^{190m,g}Re, ^{198}Ir; γ-ray spectra of short-lived unseparated fission products; K-conversion in ^{164}Ho; delayed neutron-spectra from unseparated fission products and from ^{85}As); nuclear fission (charge distribution in the chain 132 from ^{235}U(n_{th},f) and ^{235}U(n_{th},f) and around the 50-neutron shell from ^{235}U(n_{th},f)) search for superheavy elements in nature; activation analysis (detection of gunshot residues, analysis of hair and jewels, determination of copper in lead glasses, determination of lead by x-ray excitation with heavy ions). (auth)

13484 (BNL-17271) CURRENT STATUS OF MEASUREMENTS OF GROUND STATE MOMENTS OF NUCLEI. Cohen, V. W. (Brookhaven National Lab., Upton, N. Y.). 1972. 42p. (CONF-720932-4). Dep. NTIS.

From International conference on nuclear moments and nuclear structure; Osaka, Japan (4 Sep 1972).

While the spins of all stable nuclei have been determined measurements of magnetic dipole and higher moments are being made with increasing precision with accuracy adequate to determine hyperfine anomalies. The methods of nuclear resonance in many variants, atomic beam resonance, and optical pumping are being actively persued to determine spins and moments of short-lived nuclei. A number of recent results are given which indicate directions of current progress. (auth)

13485 (CONF-720309-, pp 104-12) COUPLED PARTICLE-PAIRING VIBRATIONAL EXCITATIONS IN ^{141}Nd, ^{143}Nd, AND ^{139}Pr BY (p,t) REACTIONS. Yagi, K.; Sato, K.; Aoki, Y. (Osaka Univ.). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Triton spectra and angular distributions were measured for (p,t) reactions on ^{143}Nd, ^{145}Nd, and ^{141}Pr at a proton energy of 52.1 MeV using a broad-range magnetic spectrometer and a proportional counter system. Strong L = 0 and L = 2 transitions were observed and these are interpreted as coupled particle-pairing vibrational excitations. (J.W.R.)

13486 (CONF-720309-, pp 394-7) (p,t) REACTIONS ON $^{134\ 136\ 138}$Ba. Taketani, H.; Adachi, M.; Ogawa, M.; Ashibe, K.; Hattori, T. (Tokyo Inst. of Tech.). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Angular distributions for the (p,t) reaction on ^{134,136,138}Ba at E_p = 52 MeV were measured using a broad-range magnetic spectrometer. Ground-state Q values were determined and relative cross-section ratios were obtained. (J.W.R.)

13487 (CONF-720309-, pp 398-401) (p,t) REACTIONS ON Ru ISOTOPES IN THE NEW TRANSITIONAL REGION. Taketani, H.; Namai, R.; Adachi, M.; Hattori, T.; Ogawa, M. (Tokyo Inst. of Tech.). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The level structure of ^{98,100,102}Ru was studied using the (p,t) reaction on ^{100,102,104}Ru at E_p = 52 MeV. Triton angular distributions from 6 to 60° were measured using a broad-range magnetic spectrometer. Excited states up to the region of two-phonon states were observed. The results show that the transitional aspects of Ru isotopes are more gradual than those of Mo isotopes. (J.W.R.)

13488 (IS-T-535) DECAY ENERGIES OF GASEOUS FISSION PRODUCTS AND THEIR DAUGHTERS FOR A-88 TO 93. Clifford, J. R. (Ames Lab., Iowa). Nov 1972. Contract W-7405-eng-82. 101p. Dep. NTIS.

Thesis.

A systematic study of beta decay energies has been made for mass-separated activities of Kr gaseous fission products and their daughters at the TRISTAN on-line separator facility at the Ames Laboratory Research Reactor. A Pilot B well-type plastic scintillator was used in coincidence with a 60cm^3 Ge(Li) gamma detector as described by Wohn et al. The following beta decay end-point energies have been determined: ^{88}Kr, 2.93 ± 0.03 MeV; ^{88}Rb, 5.30 ± 0.06 MeV; ^{89}Kr, 4.93 ± 0.06 MeV; ^{90}Kr, 4.35 ± 0.05 MeV; ^{90}Rb, 6.32 ± 0.06 MeV; ^{91}Kr, 6.12 ± 0.07 MeV; ^{91}Rb, 5.68 ± 0.04 MeV; ^{92}Kr, 5.97 ± 0.08 MeV; ^{92}Rb, 7.58 ± 0.15 MeV; ^{92}Sr, 1.93 ± 0.03 MeV; ^{93}Kr, 8.3 ± 0.5 MeV; and ^{93}Rb, 7.23 ± 0.10 MeV. The decay energies were compared with previous measurements, systematics predictions, and two currently accepted mass relations. The energies were used to predict the beta decay energies for thirteen additional nuclei by means of systematics. (auth)

13489 (JINR-P6-6651) ^{137}Ce LEVEL POPULATION BY ELECTRON CAPTURE AND POSITRON EMISSION AT ^{137}Pr DECAY. Buttsev, V. S.; Gromov, K. Ya.; Kalinnikov, V. G.; Morozov, V. A.; Muminov, T. M.; Khalikulov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The ^{137}Pr radiation produced in the reaction of deep spallation of gadolinium by fast protons (E_p = 660 MeV) was studied. The energies and intensities of 120 γ-transitions were measured with great accuracy. The multipole types were determined for a number of transitions. The maximum energy of emitted positrons was determined to be (1680 ± 10 keV). To the scheme suggested there are introduced new levels: 1105.2; 1258.9; 1271.5; 1288.5; 1476.6; 1925.2; 1933.9; 2113.4; 2347.2 and 2480.0 keV. The existence of the levels was established by γγ-coincidences. The lifetime of 160.32 keV state is measured ($T_{½}$ = 0.79 ± 0.14 nsec). (auth)

13490 (JINR-P6-6794) DETERMINATION OF THE ENERGY OF ^{134}Ce → ^{134}La AND ^{160}Er → ^{160}Ho. Aleksandrov, V. S.; Buttsev, V. S.; Vylov, Ts.; Gromov, K. Ya.; Kalinnikov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spectra are measured for x rays of K series of equilibrium mixtures of isotopes ^{160}Er → ^{160}Ho → ^{160}Dy and ^{134}Ce → ^{134}La → ^{134}Ba. For the ratio of intensities of K-series lines the values are obtained: $I_k(Dy)/I_k(Ho)$ = 1.66 ± 0.04 and $I_k(La)/I_k(Ba)$ = 2.43 ± 0.10. The fractions of K capture in the electron capture $K/\epsilon(Er)$ = 0.795 ± 0.020 and $K/\epsilon(Ce)$ = 0.72 ± 0.08. The values are obtained for decay energies ^{160}Er $\xrightarrow{\epsilon}$ ^{160}Ho(Q_ϵ = 310 ± $^{190}_{70}$ keV, lg ft = 4.8 ± $^{0.6}_{0.3}$) and ^{134}Ce $\xrightarrow{\epsilon}$ ^{134}La(Q_ϵ = 110 ± $^{90}_{30}$ keV, lg ft = 3.9 ± $^{0.7}_{0.5}$). (auth)

13491 (JINR-P6-6804) STUDY OF THE RADIOACTIVE DECAY OF ^{137}Nd (38.5 MIN). ISOMERISM IN NUCLEUS ^{137}Nd. Buttsev, V. S.; Vylov, Ts.; Gromov, K. Ya.; Kalinnikov, V. G.; Gromova, I. I.; Morozov, V. A.; Muminov, T. M.; Fuya, Kh.; Khalikulov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

Using precision spectrometers the decay of ^{137}Nd was studied. The half-life of ^{137}Nd ($T_{½}$ = 38.5 ± 1.5 min) is measured more accurately. The end-point energy of the positrons is measured to be E_{bound} = 2400 ± 40 keV. About 160 new γ-transitions are found. For the first time the decay mode ^{137}Nd → ^{137}Pr is suggested which includes 37 new levels. The levels in the mode are proved by γ−γ coincidences. The half-lives are measured for the states 74.5 keV ($T_{½}$ = (0.38 ± 0.03) ns) and for 306.4 keV ((0.5 ± 0.2) ns). It is shown that some low-lying states are of collective nature. It is supposed that in the nucleus ^{137}Nd there exists the isomeric state with $T_{½}$ = 20−25 min. (auth)

13492 DECAY OF 2.4-SEC ^{100}Nb. Herzog, W. (Univ., Mainz). Z. Phys.; 256: No. 5, 448-56(1972). (In German).

The nuclide ^{100}Nb was produced by irradiation of enriched ^{100}Mo targets with 14-MeV neutrons, and its decay properties were investigated employing scintillation and semiconductor spectrometers and coincidence techniques. A half-life of 2.4 ± 0.3 and a Q_β value of 5.8 ± 0.2 MeV were found. From 27 gamma rays, 20 transitions, representing 95% of the observed gamma-ray intensity, could be placed in a decay scheme comprising 10 excited states of ^{100}Mo. (4 figures, 2 tables) (auth)

13493 HALF-LIFE AND GAMMA-RAY ENERGIES OF ^{144}La. Ohyoshi, A. (Kumamoto Univ., Japan); Ohyoshi, E.; Tamai, T.; Takemi, H.; Shinagawa, M. J. Nucl. Sci. Technol. (Tokyo); 9: No. 11, 658-61(Nov 1972).

A procedure using a complexing agent (NTA) in paper electromigration has been devised to achieve rapid separation of fission product lanthanum. This technique permits direct observation of the decay of the 42 sec ^{144}La without interference from the radiation of other fission products. The γ-ray spectrum of ^{144}La has been measured with a high-resolution Ge(Li) detector, and the following γ-transitions were observed: 397, 434, 541, 586, 704, 734, 845, 951, and 1292 keV. Their relative intensities were also determined. From the decay plots of the two strong photopeaks at 397 and 541 keV, the half-life of the ^{144}La was determined as 42.4 ± 0.6 sec which is more accurate than that of 41 ± 3 sec previously reported. It is concluded that the separation procedure used in the present study can be adapted to the isolation of other short-lived fission products as well whenever their metal ions from the complexes by different values of the equilibrium constant. (auth)

13494 DECAY OF ^{101}Mo AND ^{101}Tc. Cook, W. B.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 50: No. 17, 1957-77(1 Sep 1972).

The energy levels of ^{101}Tc and ^{101}Ru were investigated through a study of the decays of 14.6 min ^{101}Mo and 14.0 min ^{101}Tc. Singles gamma-ray spectra were obtained with high-resolution Ge(Li) detectors having volumes of 0.8 cm^3 and 12 cm^3. A 36 cm^3 Ge(Li)−40

cm^3 Ge(Li) coincidence spectrometer operated in a two-parameter configuration (4096 × 4096) was employed in collecting coincidence data. More than 180 gamma transitions were observed in the two decays: 152 are definitely assigned to the decay of ^{101}Mo, 25 to the decay of ^{101}Tc. These gamma rays were incorporated into level schemes involving 45 levels in ^{101}Tc and 10 levels in ^{101}Ru. On the basis of beta and gamma selection rules, spin–parity assignments were suggested for many of the levels. (auth)

13495 INNER SHELL VACANCY CREATION IN THE BETA DECAYS OF ^{147}Pm AND ^{185}W. Campbell, J. L.; Law, J. (Univ. of Guelph, Ont.). Can. J. Phys.; 50: No. 20, 2451-60(15 Oct 1972).

K- and L-shell auto-ionization probabilities were measured for the beta decays of ^{147}Pm and ^{185}W by Ge(Li) and Si(Li) spectroscopy techniques that eliminate electron detection. The results obtained are in good agreement with values calculated from a model based on vacancy creation mechanisms of shake-off and shake-up and employing a simple correction for direct collisions. (auth)

13496 STUDY OF THE EVEN MOLYBDENUM ISOTOPES WITH THE (p,t) REACTION. Moalem, A. (Tel-Aviv Univ., Ramat Aviv, Israel); Moinester, M. A.; Alster, J.; Dupont, Y. Nucl. Phys.; A196: No. 3, 605-14(1972).

The ^{96,98}Mo(p,t) reactions are measured at a proton energy of 40 MeV. Two-nucleon transfer DWBA calculations are used to extract spin and parity assignments. Several new J^π assignments are made. Enhancement factors are extracted assuming the simplest neutron configuration. The effects of higher orbits on the transition strength is demonstrated by the use of wave functions based on single neutron pick-up results. Comparisons are made to (p,t) results on the even Zr isotopes. It is concluded that the two additional protons in Mo compared to Zr strongly affect the neutron structure in the heavier Mo isotopes. (auth)

13497 USE OF A Ge(Li) DETECTOR FOR INVESTIGATING NUCLEAR GAMMA RESONANCE SCATTERING AND THE LIFETIME OF THE 2390.7 keV LEVEL OF ^{116}Sn. Kaipov, D. K.; Kosyak, Yu. G.; Smirin, L. N.; Shubnyi, Yu. K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 64-6(1972). (In Russian).

A scintillation spectrometer with a NaI(Tl) crystal was used in the study of the nuclear γ-resonance scattering by ^{116}Sn nuclei. The cross section of resonance scattering of γ-quanta with energies of 1293.4 keV by ^{116}Sn was obtained with a ^{116m}In source ($T_{1/2}$ = 54 min). The lifetime of the 2390.7-keV level of ^{116}Sn is $(4 \pm 2) \times 10^{13}$ sec. (K.S.W.)

13498 EVIDENCE FOR PARTICLE CORE COUPLING IN THE N = 83 NUCLEUS ^{147}Gd. Kownacki, J. (Forskningsinstitutet foer Atomfysik, Stockholm); Ryde, H.; Sergejev, V. O.; Sujkowski, Z. Phys. Scr.; 5: No. 1-2, 66-72(1972).

High-spin levels in ^{147}Gd are excited in the ^{144}Sm (α,n) reaction. Based on excitation function measurements, angular distribution, and two-dimensional $\gamma-\gamma$ coincidence experiments, a level scheme of ^{147}Gd is proposed. The ground state ($^7/_2^-$) and the two lowest energy levels at 997.4 and 1152.8 keV are described within the shell model by the single particle orbitals $2f_{7/2}$, $1h_{9/2}$, and $3p_{3/2}$. The higher lying states in ^{147}Gd may arise from the coupling of a $1h_{9/2}$ or $2f_{7/2}$ particle to the excited levels of the core. (auth)

13499 ELECTRON SCATTERING STUDIES OF SOME EVEN ISOTOPES OF SAMARIUM. Cardman, L. S. New Haven; Yale Univ. (1972). 240p. University Microfilms Order No. 72-29,524.

Elastic electron scattering from ^{148,150,152}Sm has been investigated using the Yale University Electron Accelerator. The incident energy was varied between 40 and 60 MeV, and angular distributions were obtained for scattering angles between 70° and 160°. Cross sections measured in the region of the first diffraction minimum differ by as much as 10% from those expected for these nuclei on the basis of the results of muonic x-ray experiments and K x-ray isotope shift experiments. Estimates by Rawitscher of the effect of virtual nuclear excitations, which have been neglected in the conventional phase-shift analyses of electron scattering data, suggest that these excitations may be responsible for the observed discrepancies. (Diss. Abstr. Int., B)

13500 STUDY OF (p,n) REACTIONS IN ^{94}Mo AND ^{96}Mo. McPherson, M. R. Lexington, KY; Univ. of Kentucky (1972). 101p. University Microfilms Order No. 72-29,283.

Thesis.

Differential cross sections for the ^{94}Mo(p,n)^{94}Tc reaction were measured at scattering angles of 30 and 120 degrees for neutrons which leave ^{94}Tc in its first five excited states. Three isobaric analog resonances at 5.74, 5.82, and 6.04 MeV bombarding energies were studied in this reaction. An analysis of these resonances was performed using the theory of Robson, which yielded information as to the analog states as well as residual nuclear states. Angular distributions of these neutrons were measured at 5.5, 5.9, and 6.1 MeV proton energy. From a Hauser–Feshbach analysis of the off-resonance angular distributions, the following spin and parity assignments were suggested for levels in the residual nucleus, ^{94}Tc 107 keV, 2^+; 250 keV, 4^+; 350 keV, 2^- or 3^-; 470 keV, 1^+; and 487 keV, 3^+ or 4^+. The Robson analysis of the 5.74 and 5.82 MeV analog states uniquely determined the spin and parity of the 350 keV level in ^{94}Tc to be 2^-. The isobaric analog resonance at a bombarding energy of 5.39 MeV in the ^{96}Mo(p,n)^{96}Tc reaction was studied in the differential cross sections for neutrons populating several levels in ^{96}Tc. This resonance was analyzed according to the theory of Robson. Angular distributions of the neutrons were measured at 5.2, 5.39, and 5.5 MeV proton energy. The Hauser–Feshbach analysis of these data suggested spin and parity assignments for several levels in ^{96}Tc. The excitation energies of numerous excited states in ^{96}Tc, up to an excitation energy of 1.5 MeV, were determined. (Diss. Abstr. Int., B)

13501 PULSED BEAM EXPERIMENTS ON ALIGNED NUCLEAR ISOMERS IN THE MICROSECOND REGION. Ivanov, E. A.; Pascovici, G.; Iordachescu, A. (Inst. for Atomic Physics, Bucharest). pp 392-405 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13502 OCCUPATION NUMBERS AND SHELL CLOSURE IN THE ZIRCONIUM ISOTOPES. Gloeckner, D. (Argonne National Lab., IL). Phys. Lett.; 42B: No. 4, 381-4(25 Dec 1972).

The zirconium isotopes are described by a shell model with configurations $(2p_{1/2}, 1g_{9/2})^2$ for protons and $(2d_{5/2}, 3s_{1/2})^n$ for neutrons. The model reproduces the observed ground-state proton occupation numbers, and predicts near-closure of $2p_{1/2}$ proton and $2d_{5/2}$ neutron shells in ^{96}Zr. (auth)

13503 STUDY OF LOW-LYING STATES IN ^{92}Tc WITH THE ^{92}Mo(^{3}He,t) REACTION. Hayakawa, S. I. (McGill Univ., Montreal); Mark, S. K.; Lee, J. K.; (and others). Nucl. Phys.; A199: No. 3, 560-70(1973).

States in ^{92}Tc were studied by means of the ^{92}Mo(^{3}He,t) reaction at 27.5 MeV. The Q-value for this reaction and the excitation energy of the isobaric ground state analog of ^{92}Mo were determined to be -7.882 ± 0.030 MeV and 3.813 ± 0.030 MeV, respectively. Strongly populated levels in ^{92}Tc appear to belong to configurations arising from the $(1g_{9/2})_\pi(1g_{9/2})_\nu^{-1}$ multiplet. (auth)

13504 TRANSITION PROBABILITIES IN ^{146}Eu. Holmberg, L.; Stefansson, V.; Becker, J.; Sergeev, V. (Univ. of Stockholm). Z. Phys.; 257: No. 2, 101-7(1972).

Transition probabilities in the odd–odd nucleus ^{146}Eu were measured. A recent determination of the lifetime of the 115.6-keV level has indicated a strong retardation of the 115.6-keV M1 transition. In contrast, the present results are $T_{1/2}(230.3) \leq 165$ ps, $T_{1/2}(115.6) \leq 160$ ps. The E2 cross-over transitions of 269.5 and 230.3 keV were not found in the Ge(Li) gamma spectrum. All results are in agreement with the single-particle model. (2 figures, 2 tables) (auth)

13505 ISOMER RATIOS AND THE SHIFTED FERMI GAS MODEL. Rao, A. L.; Rama Rao, J. (Andra Univ., Waltair, India). Lett. Nuovo Cim.; 5: No. 16, 1025-6(16 Dec 1972).

Isomer ratios were determined for neutron capture reactions on the target nuclei ^{108}Pd, ^{110}Pd, and ^{196}Pt at an incident neutron energy of 25 ± 5 keV. The experimental ratios were compared with theoretical predictions based on the three models of nuclear level density, namely the shifted Fermi gas model, the superconductor model, and the independent pairing model, to test their validity. (W.D.M.)

13506 PROTON PICK-UP FROM ^{92}Mo. Chapman, R. (Atomic Weapons Research Establishment, Eng.); Kitching, J. E. McLatchie, W. Nucl. Phys.; A196: No. 2, 347-52(1972).

The reaction ^{92}Mo(t,α)^{91}Nb has been carried out at a triton bombarding energy of 12 MeV. Angular distributions of the emitted α-particles were obtained and compared with DWBA predictions. Relative spectroscopic factors were obtained for six low-lying states and are discussed with reference to shell-model calculations. (auth)

13507 SPIN OF THE 673 keV LEVEL AND MULTIPOLARITY OF TRANSITIONS IN ^{105}Pd. Behar, M.; Grabowski, Z. W. (Purdue Univ., Lafayette, IN). Nucl. Phys.; A196: No. 2, 412-20(1972).

Gamma-gamma directional correlation experiments were performed on five cascades in ^{105}Pd populated from the electron

capture decay of ^{105}Ag(40 d). Two Ge(Li) detectors in a coincidence arrangement were used in this measurement. The directional correlation coefficients for the 393 keV – 280 keV $\gamma-\gamma$ cascade, together with previously determined conversion coefficients, give a unique spin $\frac{1}{2}^+$ assignment for the 673 keV level. The E2/M1 mixing ratios determined for the transitions in ^{105}Pd are $\delta(280) = 0.132 \pm 0.008$, $\delta(319) = -(0.110^{+0.024}_{-0.040})$, $\delta(370) = 0^{+0.01}_{-0.05}$, $\delta(393) = 0^{+0.01}_{-0.05}$. The 645 keV transition was found to be E1 + ≦0.02% M2 character. (auth)

13508 γ-RAY SPECTRUM FOLLOWING THE β-DECAY OF ^{147}Nd. Fellmann, S.; Patt, B. (Univ., Marburg, Ger.). Z. Phys.; 257: No. 2, 177-82(1972).

The still-existing discrepancies in the γ-ray spectrum accompanying the β^- decay of ^{147}Nd were able to be cleared up by careful measurements with high-resolution Ge(Li) detectors. It was shown that these discrepancies are caused by radioactive impurities of ^{148m}Pm; thus, several energy levels and γ-ray transitions reported in earlier papers are excluded. The experimental level scheme is compared with the predictions of intermediate-coupling theory. (3 figures) (auth)

13509 POSSIBILITY OF MEASUREMENT OF THE ENERGY OF THE METASTABLE NUCLEAR LEVELS BY LASER SPECTROSCOPY OF THE MOLECULAR VIBRATIONAL TRANSITIONS. Letokhov, V. S. (Inst. of Spectroscopy, Moscow). Phys. Lett.; 41A: No. 4, 333-4(9 Oct 1972).

In the present letter a method is proposed of measuring an excitation energy of the metastable states nuclei (of the isomeric nuclei), based on the isomeric shift of the molecular vibrational frequency The up-to-date methods of the infrared laser spectroscopy allow to detect and measure the isomeric shift with a high accuracy The method considered gives a possibility of the nuclear level spectroscopy by laser radiation. (auth)

13510 MASS SPECTROSCOPIC STUDIES ON THE MECHANISM OF IONIZATION OF ATOMS FORMED AS A RESULT OF RADIOACTIVE DECAY PROCESSES. II. Aratani, M.; Inarida, M. (Inst. of Physical and Chemical Research, Wako, Japan). Shitsuryo Bunseki; 20: No. 2, 111-16(Jun 1972). (In Japanese).

Measurements have been made on the charge states of ions produced by the electron capture decay of ^{109}Cd (453d). The apparatus employed was a pulse-counting mode magnetic spectrometer, consisting of an ion source chamber, an analyzer tube, a detector and 3-channel pumping systems. The radionuclide, ^{109}Cd, produced by the nuclear reaction, ^{109}Ag(d,2n) ^{109}Cd, was isolated without an isotopic carrier by the solvent extraction procedure developed by M. Inarida. A HCl solution of carrier-free ^{109}Cd was dropped on stainless steel meshes, which were later mounted to the ion source chamber. The ions produced by the electron capture decay of ^{109}Cd on the solid surface were pulled out, analyzed by the magnetic field, and counted by a 16-stage Cu–Be electron multiplier. ^{109}Cd decays to the first excited state of ^{109}Ag, which has a half life of 40 sec. Emitting 87.7 keV gamma ray, the state deexcites to the ground state of ^{109}Ag. The gamma transition has an internal conversion coefficient larger than unity. The charge spectrum of the ions produced by the decay has shown that the most abundant species is singly-charged ions. (auth)

13511 EXPERIMENTAL INVESTIGATION OF THE NUCLEUS ^{100}Tc. Tarr, P. W. Moscow, ID; Univ. of Idaho (1972). 99p. University Microfilms Order No. 72-30,525.

Thesis.

The low energy structure of the odd-odd nucleus ^{100}Tc is investigated by means of the reaction ^{99}Tc(n,γ)^{100}Tc and the reasons this structure is of interest are discussed. A discussion of the experimental apparatus and methods is presented. A 35 cm^3 Ge(Li) detector (FWHM = 1.8 keV at 1332 keV) was used to measure the capture gamma rays. A total of 51 new gamma rays below 2 MeV and 28 new gamma rays above 2 MeV were found. From these measurements a level scheme relative to the capture state was deduced. (Diss. Abstr. Int., B)

13512 NUCLEAR DATA SHEETS. Nucl. Data, Sect. B; 8: No. 3, 193-293(Sep 1972).

Recent References is a current guide to experimental nuclear physics papers, and is issued three times per year as part of the Nuclear Data Sheets. In the first section, every article is listed under each nucleus for which it contains pertinent information. The information is described by a key word string as explained on the next page. From the key words, a user should be able to tell whether the indexed paper contains results that are relevant to his interests. Radioactivity papers are listed under the parent, not the daughter, nucleus. Reaction papers are listed under the nucleus for which level properties were determined. (auth)

13513 NUCLEAR QUADRUPOLE INTERACTIONS OF THE EXCITED STATES OF ^{117}In AND ^{111}Cd IN Cd COMPOUNDS. Raghavan, R. S.; Raghavan, P.; Friedt, J. M. (Technische Univ., Munich). Phys. Rev. Lett.; 30: No. 1, 10-13(1 Jan 1973).

Time-differential perturbed angular correlation experiments on the excited nuclear levels of ^{117}In and ^{111}Cd in Cd compounds show that β decay and (n,γ) reaction after-effects are absent and that the ratio of the quadrupole interaction frequency at the Cd and In sites in many cases is a constant independent of the structural type of the compound. This is interpreted as evidence for the ionic nature of the Cd and In bonds. The quadrupole moment of the 247-keV level of ^{111}Cd is derived to be $|Q| = 0.77(12)$ b. (auth)

13514 TEST OF THE LANE MODEL FOR NUCLEON–NUCLEUS OPTICAL POTENTIALS. Carlson, J. D.; Lind, D. A.; Zafiratos, C. D. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 30: No. 3, 99-102(15 Jan 1973).

Isospin-dependent potentials, determined from observed quasi-elastic (p,n) angular distributions, and a good set of proton optical potentials are used to determine a set of neutron optical potentials. The elastic scattering predictions from these neutron potentials agree with existing neutron scattering data. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 13399, 13433, 13483, 13490, 13495, 13499, and 13642.

13515 (CONF-720309–, pp 357-64) INELASTIC PROCESSES IN PROTON INDUCED TRANSFER REACTIONS ON ^{186}W. King, C. H.; Callender, W. D.; Stein, N. (Yale Univ., New Haven). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Angular distributions were measured for the ^{186}W(p,t) reaction at an incident energy of 18 MeV. The results were compared with theoretical predictions made using DWBA theory and coupled-channel theory including inelastic excitations. It is shown that transitions to the 2^+ and 4^+ ground-state band are dominated by inelastic effects. (J.W.R.)

13516 (CONF-720309–, pp 365-71) (p,t) POPULATION OF 0^+ STATES IN ^{158,160,162}Dy AND ^{164,166}Er. Maher, J. V.; Kolata, J. J.; Miller, R. (Univ. of Pittsburgh). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The (p,t) reaction on ^{160,162,164}Dy and ^{166,168}Er was studied at a proton energy of 17.5 MeV. Outgoing tritons were detected by photographic emulsions in the focal plane of a split-pole spectrograph and angular distributions were measured for l = 0 transitions. Characteristics of the strongly excited 0^+ states are discussed. (J.W.R.)

13517 (JINR–E7-6721) LIFETIMES OF ROTATIONAL STATES IN ^{164}Yb AND ^{162}Yb. Bochev, B.; Karamyan, S. A.; Kutsarova, T.; Nadzhakov, E.; Venkova, Ts.; Kalpakchieva, R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The lifetimes of several transitions in the ground-state rotational bands (g.s.r.b.) of ^{164}Yb and ^{162}Yb were measured. The (^{40}Ar, 4n) reaction was used and the recoil-distance Doppler-shift method employed. The deduced B(E2) values are compared with those of the rigid-rotor model. Quadrupole moments Q_0 and deformations β are determined. (auth)

13518 (LYCEN-7248) DECAYS OF 5.5 MIN ^{168}Lu AND 6.7 MIN ^{168m}Lu. Charvet, A.; Chery, R.; Do Huu Phuoc, Duffait, R.; Emsallem, A.; Marguier, G. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 17p. Dep. NTIS (U. S. Sales Only).

An attempt was made to remove certain discrepancies from previous results concerning the decay of ^{168}Lu produced by (α,5n) reactions with ^{169}Tm. Isotopes having half-lives of 5.5 and 6.7 minutes were observed instead of the usual isotopes having a half-life of 7 minutes. The corresponding Q values were observed to be 4470 ± 80 keV and 4690 ± 100 keV. Decay schemes are given for each isomeric state. The structure of the levels is discussed in the framework of current nuclear models. (France)

13519 DETAILED Ge(Li)–Ge(Li) COINCIDENCE STUDIES OF LEVELS IN ^{152}Sm AND ^{152}Gd. Baker, K. R.; Hamilton, J. H.; Ramayya, A. V. (Vanderbilt Univ., Nashville). Z. Phys.; 256: No. 5, 387-415(1972).

The decay of 12.4-y ^{152}Eu to ^{152}Sm and ^{152}Gd was studied in a high-resolution singles measurement and two 4096 × 2048 Ge(Li)–Ge(Li) coincidence studies. Forty-five gates were analyzed in order to confirm or establish the placement of the γ rays as well as to determine accurately the intensities of the 12 doublets, which included several not previously reported. A new $\gamma-\beta$ interband transition, $4^+_\gamma \rightarrow 2^+_\beta$ (561.4 keV), a possible $3^+_\gamma \rightarrow 2^+_\beta$ (423.7 keV) transition, and a new 330.9-keV transition between the 4^+_γ level and the $I^\pi K = 3^-0$ octupole level were established from coincidence data. Levels at 1757.0 keV in ^{152}Sm and 1282.5, 1318.7, and 1692.2 keV in ^{152}Gd were established on the basis of coincidence data. These data also establish for the first time the population in the ^{152}Eu decay levels at 1680.0 and 1047.9 keV in ^{152}Sm and ^{152}Gd, respectively, as well as a new level at 1700.8 keV in ^{152}Sm. (9 figures, 6 tables) (auth)

13520 LEVEL SCHEME OF ^{155}Tb. Barat, J. L.; Treherne, J. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A199: No. 2, 386-400(1973). (In French).

The decay scheme of ^{155}Dy(10h) was investigated with an iron-free double-focussing spectrometer, a silicon detector located in a magnetic field, and Ge(Li) detectors; $\gamma-\gamma$ coincidences were recorded on a two-dimensional pulse analyzer (1000 × 1000). The level scheme of ^{155}Tb shows some new levels and gives the previous ones with better accuracy. A tentative assignment of spins is given in terms of the expected configurations. (auth)

13521 MULTIPOLE MIXING RATIOS OF ELECTROMAGNETIC TRANSITIONS IN ^{152}Gd. Kalfas, C. A. (Univ. of Sussex, Eng.); Hamilton, W. D.; Fox, R. A.; Finger, M. Nucl. Phys.; A196: No. 3, 615-31(1972).

Using $\gamma-\gamma(\theta)$, $\gamma(\theta)$ (nuclear orientation) and $e_k-\gamma(\theta)$ directional correlation techniques, the multipole character of some transitions connecting the quadrupole and octupole quasi-vibrational bands to the ground state quasi-rotational band in ^{152}Gd following the decay of ^{152}Tb was studied. For the $\gamma-\gamma$ directional correlation measurements a high-energy resolution system employing a Ge(Li) and a NaI(Tl) detector was used while for the $e_k-\gamma$ correlation we used a NaI(Tl) and magnetic lens spectrometer system. The nuclear orientation measurements were carried out at low temperatures obtained with a ^{3}He–^{4}He dilution refrigerator. The results show that the $2^+ \rightarrow 2^+$ transition between the β-vibrational and the ground state bands contains ≈10% M1 admixture, $\delta = -3.05 \pm 0.14$, and a large E0 contribution while the similar transition from the γ-vibrational band has $\delta = 4.3 \pm 0.7$. These results are compared with Kumar's predictions for similar transitions in ^{152}Sm. Three other mixing ratios were also determined. (auth)

13522 ACTIVATION CROSS SECTIONS OF Yb ISOTOPES FOR (n,p) AND (n,α) REACTIONS AT 14.5 MeV. Tuurnala, T.; Pursiheimo, V. (Univ. of Helsinki). Phys. Scr.; 5: No. 4-5, 183-5 (1972).

The following activation cross sections for the (n,p) and (n,α) reactions on Yb isotopes have been measured at 14.5 ± 1.0 MeV using the mixed powder method with Ge(Li) γ-ray detection: ^{172}Yb(n,p)^{172}Tm (63.8 h), 6.3 ± 0.8 mb; ^{173}Yb(n,p)^{173}Tm (8.24 h), 4.2 ± 0.3 mb; ^{174}Yb(n,p)^{174}Tm (5.4 min), 2.1 ± 0.3 mb; ^{176}Yb(n,p)^{176}Tm (1.9 min), 0.55 ± 0.14 mn; ^{174}Yb(n,α)^{171}Er (7.52 h), 0.82 ± 0.05 mb; and ^{176}Yb(n,α)^{173}Er (1.4 min), 0.33 ± 0.09 mb. The (n,p) cross sections agree well with Gardner's predictions. Both the (n,p) and (n,α) cross sections have also been compared with calculations based on evaporation approximation. (auth)

13523 CONVENIENT GRAPH PAPER FOR DEPICTING THE BEHAVIOR OF THE MOMENT OF INERTIA OF HIGH SPIN NUCLEAR ROTATIONAL STATES. der Mateosian, E. (Brookhaven National Lab., Upton, NY). Nucl. Instrum. Methods; 105: No. 3, 595-6(1972).

A graph paper is described which is useful in the study of the behavior of the moment of inertia for high-spin states of deformed even–even nuclei. (2 figures) (auth)

13524 ELECTRON SCATTERING STUDIES OF THE ^{184}W AND ^{186}W NUCLEI. Kalinsky, D. New Haven; Yale Univ. (1972). 158p. University Microfilms Order No. 72-29,735.

Thesis.

Anomalous results obtained in recent electron scattering experiments suggest that a dispersion correction may contribute significantly to elastic cross sections in the region of the first diffraction minimum. Such a dispersion correction describes the effect of possible virtual nuclear excitations, which have been neglected in the conventional phase-shift analyses of electron scattering data. To investigate these effects, the Yale University Electron Accelerator has been used to study the scattering from ^{184}W and ^{186}W at incident energies between 40 and 65 MeV and scattering angles between 70° and 150°. No evidence of a dispersion effect is seen in the nucleus ^{186}W. In the case of ^{184}W, a comparison of the measured cross sections with those expected on the basis of the results of muonic x-ray experiments indicates that any dispersive effect is limited to less than 10% in the region of the first diffraction minimum. (Diss. Abstr. Int., B)

13525 M3–E4 MIXTURE OF 514.7 keV ISOMERIC TRANSITION IN ^{175}Yb. Cojocaru, V. (Inst. for Atomic Physics, Bucharest). pp 347-52 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13526 USE OF ^{155}Eu IN THE MEASUREMENT OF Gd L SUBSHELL YIELDS. Douglas, D. G. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 50: No. 15, 1697-1704(1 Aug 1972).

The subshell fluorescence yields ω_2 and ω_3 and the Coster–Kronig yield f_{23} were measured for Gd by the method of coincidence study of the X rays emitted by ^{155}Eu. The result is $\omega_2 = 0.182 \pm 0.008$, $\omega_3 = 0.187 \pm 0.006$, and $f_{23} = 0.223 \pm 0.011$. The values for ω_2 and ω_3 are close to theoretical predictions and to the experimental results of other workers on the neighboring element Tb. However, there is serious disagreement in the f_{23} values. (auth)

13527 DECAY PROPERTIES OF 19.0 min ^{162}Yb. Goudsmit, P. F. A.; De Boer, F. W. N.; Meijer, B. J.; Bogdanovic, M. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Phys.; A196: No. 2, 362-8(1972).

The decay properties of ^{162}Yb (19.0 min) were studied with Ge(Li) and Si(Li) spectrometers; $\gamma-\gamma$ and $e-\gamma$ coincidence measurements were performed. In contradiction to earlier results, the 44.7 keV γ-ray is found to be mainly an M1 transition, indicating that its initial and final levels are the 2^- and 1^- members of a K = 1 ground-state rotational band. Nilsson assignments to all levels involved are discussed. An upper limit of 15 ns determined for the half-life of the 163.46 keV state means that the F-selection rule in its decay does not act strongly. (auth)

13528 STUDY OF THE ROTATIONAL ENERGY SPECTRUM OF ^{169}Lu. Foin, C. (Institut des Sciences Nucleaires, Grenoble, France); Barneoud, D.; Hjorth, S. A.; Bethoux, R. Nucl. Phys.; A199: No. 1, 129-59(1973).

High-spin rotational levels in ^{169}Lu are populated in the ^{169}Tm (α,4n)^{169}Lu and ^{171}Yb(p,3n)^{169}Lu reactions and the de-excitation γ-ray cascades are studied with $\gamma-\gamma$ coincidence techniques. The rotational bands which are built on the $1/2^+$[411], $1/2^-$[541], $5/2^+$[402], $7/2^+$[404] and $9/2^-$[514] intrinsic states are identified up to high spin values; the $1/2^+$[411] and $9/2^-$[514] band heads are located at 97.4 and 439.0 keV, respectively. The rotational energy spectra are discussed within the framework of the classical rotor model. There is some evidence for the existence of coupling terms having ΔK = 2 and it is necessary to allow for a variable moment of inertia in order to explain the available data. While the Coriolis matrix elements connecting observed states near the Fermi level are smaller than predicted theoretically, the oscillating perturbations in the rotational energies in the $9/2^-$[514] band are understood only if the full theoretical force is used to represent the interactions among the high-lying orbitals. (auth)

13529 ENERGY LEVELS AND TRANSITIONS IN ^{165}Ho FROM NEUTRON SCATTERING. Barnard, E.; de Villiers, J. A. M.; Malan, J. G.; Reitmann, D.; van der Merwe, P. (Atomic Energy Board, Pretoria). Z. Phys.; 257: No. 2, 137-46(1972).

The ^{165}Ho(n,n′) and ^{165}Ho(n,n′γ) reactions were utilized to obtain information on the energy levels of ^{165}Ho up to about 1400 keV excitation. A Ge(Li) detector was used in the time-gated mode to measure the de-excitation γ rays. Neutrons were detected by a conventional time-of-flight spectrometer. Results from the two sets of measurements are combined to construct an energy level scheme for ^{165}Ho. The level scheme is compared with results from other sources, and some new levels are proposed. (2 figures, 1 table) (auth)

13530 EXPERIMENTAL STUDY OF HIGH SPIN STATES IN THE GROUND STATE BANDS OF $^{158\ 160}$Er, $^{164\ 166}$Yb, AND ^{168}Hf. Lieder, R. M.; Beuscher, H.; Davidson, W. F.; (and others) (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 257: No. 2, 147-76(1972).

Ground-state rotational bands in the deformed doubly even rare earth nuclei ^{158,160}Er, ^{164,166}Yb, and ^{168}Hf were observed in (α,8nγ) reactions. The γ spectra associated with these reactions were studied in beam using conventional spectroscopic methods. In all five nuclei the nuclear moment of inertia of the

ground-state rotational states was found to increase abruptly as higher spin states were attained. In a plot of the moment of inertia as a function of the angular velocity all five nuclei display "backbending" curves. Moreover, in ^{158}Er and ^{160}Yb, the curves after passing through a maximum bend downwards. (19 figures, 6 tables) (auth)

13531 ROLE OF ANGULAR MOMENTUM IN COMPLETE FUSION REACTIONS: $^{11}B + ^{159}Tb$, $^{12}C + ^{158}Gd$, $^{16}O + ^{154}Sm$. Zebelman, A. M. (City Univ. of New York, Jamaica); Miller, J. M. Phys. Rev. Lett.; 30: No. 1, 27-30(1 Jan 1973).

Measurements are reported for the complete-fusion cross sections for the reactions $^{11}B + ^{159}Tb$, $^{12}C + ^{158}Gd$, and $^{16}O + ^{154}Sm$ at bombarding energies such that the excitation energy of the ^{170}Yb compound nuclei that are formed is 107 MeV. The results indicate that the complete-fusion cross sections are determined by dynamical processes in the entrance channel rather than by the equilibrium properties of the compound system. (auth)

13532 NUCLEAR REACTION STUDIES OF ^{169}Tm. Preibisz, A.; Burke, D. G.; O'Neil, R. A. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A201: No. 3, 486-512(1973).

The intrinsic structure of ^{169}Tm has been studied using the (^{3}He,d) and (α,t) proton stripping reactions as well as the (d,t) and (^{3}He,α) neutron pick-up reactions. The beams of 24 MeV ^{3}He particles, 25 MeV α-particles and 12 MeV deuterons were obtained from the McMaster tandem Van de Graaff accelerator. The reaction products were analyzed with an Enge-type magnetic spectrograph and detected with photographic emulsions. The spectra have been interpreted in terms of the coupling of an odd proton and an odd neutron, each moving independently in a spheroidal potential, which gives rise to intrinsic two-quasiparticle states with $K = |\Omega_1 + \Omega_2|$. The identification of the intrinsic states was made by comparing the experimental cross-section patterns with those predicted with the aid of Coriolis coupling and distorted-wave Born approximation (DWBA) calculations. Rotational bands superimposed on the $K^\pi = 3^+$ and $K^\pi = 4^+$, $\{7/2^+[633]_n \pm 1/2^+[411]_p\}$ configurations, the first of which is the ground state, have been observed in the spectra of all four reactions. New assignments have been made for configurations resulting from coupling the $1/2^-[541]$, $1/2^+[404]$, $5/2^+[402]$ and $1/2^-[530]$ proton states to the $7/2^+[633]$ neutron state. The neutron pick-up measurements confirmed the earlier assignments based on (d,t) reaction studies and suggested tentative assignments for the $\{1/2^+[400]_n \pm 1/2^+[411]_p\}$ and $\{3/2^+[402]_n \pm 1/2^+[411]_p\}$ states. (auth)

13533 HIGH-SPIN ROTATIONAL STATES IN ^{157}Dy. Klamra, W. (Research Inst. for Physics, Stockholm); Hjorth, S. A.; Boutet, J.; Andre, S.; Barneoud, D. Nucl. Phys.; A199: No. 1, 81-109 (1973).

The γ-rays emitted when targets of ^{159}Tb and ^{155,158}Gd are bombarded with protons and α-particles, respectively, have been studied with Ge(Li) detectors and interpreted within the level scheme of ^{157}Dy. The data allow an improved determination of the half-life of the isomeric $11/2^-$ [505] level and reveal a branch in the isomeric decay which passes through a $5/2^+$ level at 162 keV. In addition there is evidence that the ground state $3/2^-[521]$ band, the $11/2^-$ [505] band and the positive-parity band are observed up to members with spin $21/2^-$, $25/2^-$ and $33/2^+$, respectively. The rotational energies and transition probabilities within these three bands are discussed within the framework of the particle-rotor model. Although a qualitative description of the available data can certainly be obtained in this way the deviations between theory and experiment are almost an order of magnitude larger than in ^{161}Dy where the deformation of the nucleus is more developed. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 13276, 13399, 13433, 13450, 13505, and 13630.

13534 (JINR-P6-6723) EXCITATION OF THREE-PARTICLE STATES IN ^{211}Rn FROM THE ELECTRON CAPTURE DECAY OF ^{211}Fr. Kempisty, T.; Korman, A.; Morek, T.; Peker, L. K.; Khartym, Z.; Khoinatski, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The gamma rays accompanying the electron-capture decay of ^{211}Fr produced in the reaction $^{197}Au(^{18}O, 4n)$ have been investigated. On the basis of gamma-gamma coincidence measurements the level scheme of $^{211}_{86}$Rn is suggested. The prominent gamma ray cascade of 540, 918 and 281 keV was found. By analogy with the level structure in ^{209}Po the 540 keV $(5/2^-)$ level is interpreted as a single-particle neutron state, f $5/2$, and the 1458 keV $(9/2^-)$ and 1739 keV $(11/2^-)$ levels as three-particle states of the p (h $9/2$)$^4_{4+,6+}$, n (p $1/2$)$^{-1}$ type. (auth)

13535 (JINR-P6-6725) SOME REGULARITIES IN THE PROPERTIES OF LOW-LYING LEVELS IN THE EVEN ISOTOPES OF Rn. DECAY OF ^{210}Fr INTO ^{210}Rn. Kempisty, T.; Korman, A.; Morek, T.; Peker, L. K.; Khartym, Z.; Khoinatski, C. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The levels in ^{210}Rn from the decay of ^{210}Fr produced in the reaction $^{197}Au(^{18}O,5n)$ have been investigated. The level scheme of ^{210}Rn has been suggested on the basis of the measurements of gamma rays and gamma-gamma coincidences. In order to obtain some information concerning the structure of ^{210}Rn levels, the experimental data on the even-even nuclei Pb, Po, Rn, and ^{214}Rn have been compared and discussed. (auth)

13536 DECAY OF THE ISOMERS ^{88m}Y, ^{142m}Pm, ^{204m}Bi, AND ^{206m}Bi. Rakivnenko, Yu. N.; Klyucharev, A. P.; Lutsik, V. A.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 1037-9(Jun 1972). (In Russian).

The decay of the short-lived isomers ^{88m}Y ($T_{1/2}$ = 13.9 × 10^{-3} s, E* = 675 keV), ^{142m}Pm ($T_{1/2}$ = 2.2 × 10^{-3} s, E* = 885 keV), ^{204m}Bi ($T_{1/2}$ = 13.0 × 10^{-3} s, $T_{1/2}$ = 1.07 × 10^{-3} s), and ^{206m}Bi ($T_{1/2}$ = 0.89 × 10^{-3} s) was studied. These isomers had been formed in the (α,3n) reaction by α particles with a bombarding energy of 38 MeV. Internal conversion electron spectra were measured, as well as the half-lives and excitation functions. The decay schemes of ^{88m}Y and ^{142m}Pm were constructed, the isomeric transitions of which possess an E3 multipole order. The energies and observed intensities of the conversion lines of the Bi isomers are reported. (tr-auth)

13537 HIGH-SPIN NEGATIVE-PARITY STATES IN ^{200}Hg FROM ^{200m}Au DECAY AND $^{198}Pt(\alpha,2n\gamma)$ REACTION SPECTROSCOPY. Cunnane, J. C.; Hochel, R.; Yates, S. W.; Daly, P. J. (Purdue Univ., IN). Nucl. Phys.; A196: No. 3, 593-604(1972).

Levels in ^{200}Hg populated in the β^- decay of the 19 h isomer of ^{200}Au and in the reaction $^{198}Pt(\alpha,2n\gamma)^{200}$Hg have been investigated. The β-decay populates an 11^- level in ^{200}Hg at 2642 keV, which deexcites through levels at the following energies (spin-parities): 2144(9^-), 1963(7^-), 1852(5^-), 1707(6^+), 947(4^+), and 368(2^+) keV. The relative γ-ray intensities measured in the in-beam experiment were invaluable in the construction of an unambiguous ^{200}Hg level spectrum. The $9^- \rightarrow 7^-$ and $7^- \rightarrow 5^-$ E2 transitions are considerably enhanced suggesting that the negative-parity levels constitute a collective "band." It is proposed that the β^- decay involves a one-particle transition between the $(h_{9/2}\pi, i_{13/2}\nu)12^-$ isomer of ^{200}Au and a $(h_{9/2}\nu, i_{13/2}\nu)$ two-neutron admixture in the ^{200}Hg 11^- state. Indications of the systematic occurrence of similar sequences of negative-parity levels in other A = 190-200 transitional nuclei are discussed. (auth)

13538 BETA-GAMMA DIRECTIONAL CORRELATION IN ^{199}Au. Unterweger, M. P. Jr. St. Louis; St. Louis Univ. (1972). 121p. University Microfilms Order No. 72-24,030.

Thesis.

The beta-gamma directional correlation in ^{197}Au has been measured for the average beta-ray energies of 127, 177, 227, and 277 keV. The 158-keV gamma rays following the 302-keV endpoint energy beta decay were measured in coincidence with the beta rays of the average energy. The objective of this experiment is to make a precise experimental measurement of the beta-gamma directional correlation as a function of 302-keV (endpoint energy) beta energy and to determine whether the ξ-approximation is valid in Au-199. The final results yield values of the $A_2(\beta)$ beta directional correlation coefficient which are smaller in magnitude than predicted by the ξ-approximation and which exhibit an energy dependence not predicted by the ξ-approximation. These results for A_{22} and $A_2(\beta)$, respectively, are −0.0131 and 0.0245 for 127 keV, −0.0046 and 0.0085 for 177 keV, −0.0091 and 0.0170 and 227 keV, and −0.0163 and 0.0306 for 277. These results differ from the values determined in an earlier experiment by El-Nesr and Othaz. A condensation of the density matrix and statistical tensor formalisms of the theory is given for future reference. A step-by-step procedure for performing similar angular correlation experiments on the equipment used in the Au-199 experiment is also presented. (Diss. Abstr. Int., B)

13539 SEARCH FOR A PYGMY RESONANCE IN RESONANT n-γ SPECTRA OF ^{197}Au. Jain, A. P. (CEN, Saclay, France). Phys. Lett.; 42B: No. 4, 419-21(25 Dec 1972).

Resonant γ-ray spectra in ^{197}Au were measured over a neutron energy range of 0.025 eV to 800 eV with a Ge(Li) detector at the 60-MeV electron linac at Saclay. No evidence was found for the

much-discussed pygmy resonance in ^{197}Au from a comparison of thermal and averaged γ-ray spectra. The earlier-observed bump in the thermal-neutron capture spectra arises mainly from Porter–Thomas fluctuations of transitions in the lowest resonance, at 4.9 eV. (auth)

13540 PRODUCTION OF ^{149}Tb FROM GOLD BY 0.2 TO 0.5 GeV PROTONS. Heydegger, H. R. (Univ. of Chicago); Van Ginneken, A. Nucl. Phys.; A196: No. 1, 156-60(1972).

The production of ^{149}Tb from gold by 200–450 MeV protons has been observed with cross sections (α-branch only) as follows: 0.0028 ± 0.0011 μb at 218 ± 14 MeV, 0.23 ± 0.09 μb at 382 ± 21 MeV, and 0.84 ± 0.34 μb at 434 ± 24 MeV. (auth)

13541 INVESTIGATION OF THE ^{208}Pb(^{12}C,^{11}B)^{209}Bi AND ^{208}Pb(^{12}C,^{13}C)^{207}Pb REACTIONS AT HIGH BOMBARDING ENERGIES. Larsen, J. S.; Ford, J. L. C. Jr.; Gaedke, R. M.; (and others) (Oak Ridge National Lab., TN). Phys. Lett.; 42B: No. 2, 205-7(27 Nov 1972).

States in ^{207}Pb and ^{209}Bi were populated in interactions of ^{208}Pb with 77, 98 and 116 MeV ^{12}C ions. Angular distributions indicated that the neutron-pickup and proton-stripping reactions were compatible, respectively, with mechanisms dependent on final and initial systems alone. (auth)

13542 ELASTIC SCATTERING OF ^{84}Kr BY HEAVY NUCLEI. Colombani, P.; Jacmart, J. C.; Poffe, N.; (and others) (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 42B: No. 2, 197-200(27 Nov 1972).

The elastic scattering of ^{84}Kr from ^{208}Pb and ^{232}Th has been studied; strong-absorption radii R are deduced. A decrease of the radius parameter r, defined by $R = r(A_1^{1/3} + A_2^{1/3})$, is found with regard to reactions with lighter ions, which can be quite well fitted by an optical spherical model. Differences observed in scattering from ^{208}Pb and ^{232}Th may be due to deformation effects. Interaction barriers are estimated. (auth)

13543 FRAGMENTS WITH $6 \leq Z \leq 15$ EMITTED FROM Au BOMBARDED WITH 2.1-GeV/NUCLEON ^{16}O IONS AND 2.1-GeV PROTONS. Sullivan, J. D. (Univ. of California, Berkeley); Price, P. B.; Crawford, H. J.; Whitehead, M. Phys. Rev. Lett.; 30: No. 4, 136-8(22 Jan 1973).

In the reaction 34-GeV ^{16}O + Au → Z, fragments with $6 \leq Z \leq 15$ are emitted with higher than geometric cross section and with a broad distribution of energies extending down to ~0.8 MeV/nucleon. Such low kinetic energies are far below the hard-sphere Coulomb barrier, and may imply extreme distortions of a nucleus raised to high temperature by the ^{16}O ion. (auth)

13544 STUDY OF LEAD ISOTOPES OF MASS 200, 198, 196, AND 194 FORMED BY (HEAVY ION,xn) REACTIONS. Pautrat, M. (Institut de Physique Nucleaire, Orsay, France); Albouy, G.; David, J. C.; (and others). Nucl. Phys.; A201: No. 3, 449-468 (1973). (In French).

The low-lying excited states of ^{194,196,198,200}Pb have been studied through the deexcitation γ-rays following the reactions Os(^{12}C,4n), W(^{16}O,4n) and Re(^{14}N,5n). Prompt and delayed spectra, $\gamma-\gamma$ coincidences, γ-ray angular distributions and γ-ray time distributions have been obtained. Half-lives were measured for the 12^+ level in the four isotopes, for the 9^- level in ^{194,196,200}Pb, for the 7^- level in ^{200}Pb and for the 5^- level in ^{196,198}Pb. The results of microscopic calculations, performed with either a Gaussian interaction or a surface delta interaction, are compared to the experimental level schemes and transition probabilities, and discussed. (auth)

13545 7 MeV DIPOLE GROUND STATE TRANSITIONS IN ^{207}Pb, ^{208}Pb, AND ^{209}Bi. Swann, C. P. (Franklin Inst., Philadelphia). Nucl. Phys.; A201: No. 3, 534-540(1973).

The Doppler-broadened 7.117 MeV line from the ^{19}F(p,$\alpha\gamma$)^{16}O reaction has been used to resonantly excite levels in ^{208}Pb at 7071 ± 2 and 7091 ± 2 keV, in ^{207}Pb at 7186 ± 5 and 7206 ± 5 keV and in ^{209}Bi at 7179 ± 5 and 7202 ± 5 keV. On the basis of angular distribution measurements the 7071 and 7091 keV levels of ^{208}Pb are assigned spins of 1 and assuming 100% ground state branching the widths are calculated to be 31 ± 3 and 17 ± 2 eV respectively. It is suggested that the states in ^{207}Pb and ^{209}Bi arise from the weak coupling of a $p_{\frac{1}{2}}$ neutron hole and an $h_{\frac{9}{2}}$ proton respectively to one or the other of the ^{208}Pb levels. The widths obtained in terms of $g\Gamma_p^2/\Gamma$ are 15 ± 4 and 25 ± 5 eV for the 7186 and 7206 keV levels of ^{207}Pb and 24 ± 5 and 30 ± 5 for the levels of ^{209}Bi respectively. These values are consistent with the weak-coupling suggestion. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 11702, 13380, 13395, 13481, 13483, and 13542.

13546 (AERE-R-6862(Rev.)) ABSOLUTE YIELDS IN THE FISSION OF ^{235}U, ^{238}U, AND ^{239}Pu IRRADIATED IN DFR. Cuninghame, J. G.; Goodall, J. A. B.; Willis, H. H. (Atomic Energy Research Establishment, Harwell (England)). May 1972. 17p. Dep. NTIS (U. S. Sales Only).

Absolute fission yields have been measured for 14 nuclides in the fission of ^{235}U and ^{239}Pu in pitch 30 of D.F.R. and for 10 nuclides in fission of ^{238}U in pitch 36. The value found for ^{99}Mo in ^{235}U fast fission of (5.43 ± 0.22)% is 10% lower than the one in current use and must now be regarded as being the correct value for the particular neutron spectrum used. The measurements have once again emphasized the truth of the assertion that if accurate fission yields are needed for any purpose, they must probably be measured in a neutron spectrum closely approximating the one for which they are required. (auth)

13547 (BNL-tr-516) NUCLEAR REACTIONS INDUCED BY XENON IONS AND THE PRODUCTION OF SUPERHEAVY ELEMENTS. Flerov, G. N.; Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P7-6523. 30p. Dep. NTIS.

A short review of experimental studies of the mechanism of complex nucleus interactions with xenon ions is presented. The technique is described, and the results of the first experiments on superheavy element synthesis are presented. (10 figures, 1 table, 47 references) (auth)

13548 (CONF-721127-1) ORELA MEASUREMENTS OF THE ^{235}U(n,f) CROSS SECTION TO 100 keV. Peelle, R. W. (Oak Ridge National Lab., Tenn.). 1972. 9p. Dep. NTIS.

From second IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972).

Two measurements of the ^{235}U(n,f) cross section in the 0.1- to 100-keV range are reported. Both measurements were made at the Oak Ridge Electron Linear Accelerator using apparatus chosen primarily to allow simultaneous measurements of fission and capture cross sections. (L.T.W.)

13549 (IS-T-544) PHOTOFISSION CROSS SECTIONS OF ^{238}U AND ^{235}U FROM 5.0 MeV TO 8.0 MeV. Anderl, R. A. (Ames Lab., Iowa). Nov 1972. Contract W-7405-eng-82. 117p. Dep. NTIS.

Thesis.

Cross sections extracted from measured yield curves are reported for photofission of ^{238}U and ^{235}U. Surface-barrier detectors were used to measure the fission yields from metal foil targets of ^{238}U (enriched to 99.97%) and ^{235}U (enriched to 97.68%) for maximum photon energies stepped from 5.0 to 8.0 MeV in 0.1-MeV increments. The photons were obtained by Compton scattering gamma rays produced by neutron capture in a nickel plate near the core of the 5-MW Ames Laboratory Research Reactor. An unfolding procedure was used to extract the smoothed cross sections from the measured yield curves. In the ^{238}U(γ,f) cross section, prominent structure is observed at 6.2 and 7.6 MeV with hints of structure at 5.5 and 7.0 MeV. The ^{235}U(γ,f) cross section shows pronounced structure at 5.9, 6.6, and 7.5 MeV with a hint of structure at 5.4 MeV. These cross sections are compared to previous photofission measurements and are discussed in the framework of Bohr's "fission channel" theory. (auth)

13550 (JINR-E7-6764) MULTINUCLEON TRANSFER REACTIONS IN THE ^{232}Th + ^{22}Ne SYSTEM. Artyukh, A. G.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V.; Vil'chinski, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 16p. Dep. NTIS (U. S. Sales Only).

Energy spectra of 58 light particles (of $3 \leq Z \leq 12$) produced in the bombardment of ^{232}Th with 174-MeV ^{22}Ne ions were measured. The kinematics of the two-body reactions leading to the production of these particles is examined in the framework of the model of Siemens, Bondorf, Gross and Dickmann. Phenomenological systematics of the cross sections, covering the whole set of the experimental data, is presented. (auth)

13551 (RFP-1883) ANNOTATED BIBLIOGRAPHY OF ^{252}Cf. Salazar, E. S.; Vasilik, D. G. (Dow Chemical U.S.A., Golden, Colo. Rocky Flats Div.). 21 Dec 1972. Contract AT(29-1)-1106. 13p. Dep. NTIS.

An annotated bibliography on ^{252}Cf is presented that is divided into sections on physical properties, neutron radiography, activation analysis, radiation protection, and production. (DHM)

13552 (WAPD-TM-1052) REVISION OF THE THERMAL PARAMETERS OF ^{233}U. Steen, N. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sep 1972. Contract AT-11-1-Gen-14. 61p. Dep. NTIS.

Two recent evaluations of the thermal parameters, by the author, and that commissioned by the I.A.E.A., have produced results which are in substantial disagreement. Consequently, a re-analysis of the available experimental data for the ^{233}U parameters η, α, $\bar{\nu}/\nu^{Cf}$, σ_f, σ_a has been carried out. These data are then used as the basis for two evaluations. The first evaluation, which is the basis for the revised thermal ^{233}U data recommended here, relies only on ^{233}U and criticality computations, thus avoiding the direct use of certain standards for which experimental data currently shows gross disparities. The second analysis utilizes the cross ratio measurements to ^{235}U in a least squares analysis similar to that used in the work commissioned by the I.A.E.A. The input and resulting output data are discussed in considerable detail. Results of computations of criticality of the Gwin and Magnuson aqueous ^{233}U criticals with the recommended data are also discussed. (auth)

13553 AVERAGE NUMBER OF PROMPT NEUTRONS $\bar{\nu}$ FOR ^{239}Pu FISSION BY NEUTRONS HAVING AN ENERGY UP TO 1.6 MeV. Volodin, K. E.; Kuznetsov, V. F.; Nesterov, V. G.; (and others). At. Energ. (USSR); 33: No. 5, 901-6(Nov 1972). (In Russian).

The dependence of the average number of prompt neutrons $\bar{\nu}$ released from ^{239}Pu per fission event on the energy of bombarding neutrons E_n in the range 0 to 1.6 MeV was measured by two relative methods having an accuracy of 0.8 to 1.0%. The correlation between irregularities in the behavior of $\bar{\nu}$ (E_n) and a number of other characteristics of the $^{239}Pu(n,f)$ fission process is discussed. (auth)

13554 CORRELATION BETWEEN ENERGIES AND ANGLES OF α-PARTICLES EMITTED IN THERMAL-NEUTRON FISSION OF ^{235}U. Nadkarni, D. M.; Kataria, S. K.; Kapoor, S. S.; Rama Rao, P. N. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Phys.; A196: No. 1, 209-15(1972).

The energy distribution and yields of the α-particles emitted in the thermal-neutron fission of ^{235}U were measured with the same detector system for the cases when the average angles between fragments and α-particles were 90°, 46°, 27°, and 11°. The data were analyzed by the Monte Carlo method to take into account the effects of the finite size of the source and the various detectors, and the following results were obtained: (i) Even at small angles with respect to the fission axis the yield of the α-particles is about 2–3% of the yield at 90°, and does not go to zero as would be expected for a true Gaussian angular distribution of a variance which fits the data around 90°. (ii) At these angles where most of the α-particle yield belongs to the non-Gaussian component, the α-particle energy distribution has a significantly higher most probable energy but the FWHM of the energy distribution is not significantly different. (iii) The rms width σ_θ of the Gaussian angular distribution is found to increase for very high ($E_\alpha > 20$ MeV) α-particle energies and also to a lesser extent for very low ($E_\alpha < 15$ MeV) energies. The origin of the yield of the α-particles at small angles, and the dependence of the rms width σ_θ on the energy are discussed. (auth)

13555 SUPERHEAVY ELEMENTS. Thompson, S. G.; Tsang, C. F. (Univ. of California, Berkeley). Science; 178: No. 4065, 1047-55(8 Dec 1972).

After a brief introduction, a general background discussion of the developments leading to the expectations concerning superheavy elements is given. Theoretically predicted nuclear and chemical properties of these elements are presented in some detail. As early attempts at synthesis were unsuccessful, many groups sought to find superheavy elements in nature; results of these searches were contradictory and inconclusive. Possibilities for producing superheavy elements in nuclear reactions with heavy ions or neutron capture are discussed; one of the most favorable target–projectile combination is $^{76}Ge + ^{232}Th$. Various physical methods for detecting the products of heavy-ion reactions are examined; and problems associated with heavy-ion reactions, such as high excitation energies, angular momentum effects, and fusion probability, are discussed. (4 figures, 2 tables, 57 references). (R.W.R.)

13556 ISOMERIC FISSION AND NUCLEAR STRUCTURE INVESTIGATIONS. II. Vilcov, N. (Inst. for Atomic Physics, Bucharest). pp 335-42 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13557 STUDY OF THE $^{236mf}U$ ISOMERIC FISSION THROUGH THE $^{235}U(n,\gamma)$ REACTION IN THE ENERGY RANGE 0.25 TO 4 MeV. Boca, I.; Sezon, M.; Vilcox, I.; Vilcov, N. (Inst. for Atomic Physics, Bucharest). pp 343-6 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13558 PENETRABILITY OF NUCLEAR FISSION BARRIER FOR MUONIC ATOMS. Blocki, J.; Sujkowski, Z.; Zielinska-Pfabe, M. (Inst. for Nuclear Research, Swierk, Poland). Phys. Lett.; 42B: No. 4, 415-18(25 Dec 1972).

The nuclear fission penetrability for muonic atoms is calculated as a function of excitation energy. The results obtained for $^{234,236,238}U$ and ^{240}Pu are compared with the fission of normal atoms. (auth)

13559 MASS MEASUREMENTS OF ^{21}O AND ^{22}O. Artukh, A. G.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V.; Wilczynski, J. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A192: No. 1, 170-6(1972).

The ground state masses of ^{21}O and ^{22}O were determined from Q-value measurements of the $^{232}Th(^{22}Ne, ^{21}O_{g.s.})^{233}U_{g.s.}$ and $^{232}Th(^{22}Ne, ^{22}O_{g.s.})^{232}U_{g.s.}$ reactions. The (M–A) values for ^{21}O and ^{22}O were found to be $9.3^{+0.3}_{-0.7}$ MeV and $11.5^{+0.2}_{-0.5}$ MeV, respectively. A detection method combining magnetic analysis and the ΔE-E technique is used. (auth)

13560 HARTREE–FOCK CALCULATION OF SUPERHEAVY MAGIC NUMBERS. Rouben, B.; Pearson, J. M.; Saunier, G. (Univ. of Montreal). Phys. Lett.; 42B: No. 4, 385-8(25 Dec 1972).

The Vautherin–Brink force is modified by making the two-body term much more realistic, while maintaining the fit to the known nuclei, in Hartree–Fock calculations. Not only $^{342}114$ but also $^{348}120$ are found to be doubly magic. (auth)

13561 ANGULAR DISTRIBUTIONS OF FRAGMENTS IN THE FISSION OF THORIUM INDUCED BY NEUTRONS IN THE RANGE 12 TO 18 MeV. Emma, V.; Lo Nigro, S.; Milone, C. (Univ., Catania, Italy). Nucl. Phys.; A199: No. 1, 186-92(1973).

The angular distributions of fragments from neutron-induced fission of ^{232}Th have been measured by means of glass detectors in the range 12.2 MeV $\leqq E_n \leqq$ 18.3 MeV. The behavior of the angular anisotropy is analyzed and the contribution of the (n,2n'f) process is discussed. (auth)

13562 SEARCH FOR FISSIONING ISOMERS IN THE RADIUM REGION. Kuks, I. M.; Matvienko, V. I.; Nemilov, Yu. A.; Selitskii, Yu. A.; Funshtein, V. B. Yadern. Fiz.; 16: No. 2, 438-9(Aug 1972). (In Russian).

A search was made for fissioning isomers which possess atomic numbers 88 or 89 by bombarding ^{226}Ra with 14.5 MeV neutrons, or with a wide spectrum of neutrons, or with 6.6 and 11.3 MeV deuterons. Isomeric fission could not be detected in these experiments, a result related to the large penetrability of the inner barrier as contrasted to the outer. (K.S.W.)

13563 INVESTIGATION OF FAST NEUTRON INTERACTION WITH ^{235}U. Knitter, H.-H.; Islam, M. M.; Coppola, M. (Central Bureau for Nuclear Measurements, Geel, Belgium). Z. Phys.; 257: No. 2, 108-23(1972).

The angular distributions of neutrons emitted by elastic, inelastic, and fission processes on ^{235}U were measured at incident neutron energies of 1.5, 1.9, 2.3, 4.0, 4.5, 5.0, and 5.5 MeV by using nanosecond time-of-flight technique. The differential elastic scattering cross sections and their angular distributions at all the seven energies are presented. The total elastic scattering cross sections, angle- and energy-integrated cross sections for the inelastically scattered neutrons in energy bands of 200 keV, fission cross sections, and the angular distributions of fission neutrons were extracted at 1.5, 1.9, and 2.3 MeV incident neutron energies. The energy distributions of the prompt fission neutrons and of the inelastically scattered neutrons are given at the incoming neutron energies of 1.5, 1.9, and 2.3 MeV, and the average fission neutron energies and the inelastic neutron evaporation temperatures were also evaluated at these energies. (7 figures, 5 tables) (auth)

13564 DETAILED CALCULATIONS OF CORRELATIONS OCCURRING IN LIGHT-PARTICLE-ACCOMPANIED SPONTANEOUS FISSION. Musgrove, A. R. de L. (Australian Atomic Energy Commission, Sutherland). Aust. J. Phys.; 25: No. 5, 499-506(Oct 1972).

Detailed trajectory calculations are made for α-particle-,

triton-, and proton-accompanied fission of ^{252}Cf. Comparison between experimental values of the quantity $\Delta\bar{E}_K/\Delta E_P$ and those deduced from the classical three point charge model suggests either that the initial Coulomb potential energy at scission has a narrow distribution (a result found by Feather 1971) or that a high degree of anticorrelation occurs between the initial potential energy and the initial kinetic energy of the fissioning system. In the latter case, the initial potential energy may be much broader. (auth)

13565 SUBTHRESHOLD NEUTRON-INDUCED FISSION OF ALIGNED ^{237}Np NUCLEI. Kuiken, R. (Kamerlingh Onnes Laboratorium, Leiden); Pattenden, N. J.; Postma, H. Nucl. Phys.; A196: No. 2, 389-400(1972).

The anisotropy in the angular distribution of fission fragments from neutron-induced fission of aligned ^{237}Np has been measured as a function of neutron energy from 0.4 to about 2000 eV. The ^{237}Np nuclei were aligned in thin layers of monocrystalline rubidium neptunyl nitrate, cooled to about 0.1 K. The interpretation of the group structure in the subthreshold fission cross section of ^{237}Np by Strutinsky's double-humped deformation barrier implies that the spins of all resonances in one group are equal. The anisotropy values for the individual resonances in the first group around 40 eV agree with the fission channel $(J^{\pi}; K) = (2^+; 2)$, where K is the projection of spin J on the symmetry axis of the compound nucleus. Some resonance groups at higher energies, which could not be resolved into individual resonances, have also been studied; the information is rather inconclusive, but tends to favor fission channels $(3^+; 2)$ and $(2^+; 2)$. (auth)

13566 FISSION-FRAGMENT CHARGE DISTRIBUTIONS IN THERMAL-NEUTRON INDUCED FISSION OF ^{239}Pu AND ^{235}U. Gunther, H. (Univ., Giessen, Ger.); Siegert, G.; Ferguson, R. L; Ewald, H.; Konecny, E. Nucl. Phys.; A196: No. 2, 401-11(1972).

Fission-fragment charge distributions of heavy fragments were investigated for fragment masses $131 \leqq A \leqq 140$ in the reactions $^{239}Pu(n_{th},f)$ and $^{235}U(n_{th},f)$. This was done by a correlated observation of β-tracks and fission-fragment tracks in nuclear emulsions for fission fragments separated with respect to mass and kinetic energy by a recoil mass spectrograph. The average nuclear charges are almost identical for both fissioning nuclei in the fragment mass range investigated. Specifically, for both systems the yields of the doubly magic $^{132}_{50}Sn_{82}$ appear to be enhanced. Both observations again support the hypothesis that in low-excitation fission of the actinides the nuclear structure of the heavy fragment plays a predominant role. (auth)

13567 POPULATION OF 0^+ EXCITED STATES IN ^{238}Pu AND ^{240}Pu BY SINGLE-NEUTRON TRANSFER REACTIONS. Friedman, A.; Katori, K. (Argonne National Lab., IL). Phys. Rev. Lett.; 30: No. 3, 102-5(15 Jan 1973).

Studies of the single-particle-transfer reactions $^{239}Pu(d,p)^{240}Pu$ and $^{239}Pu(d,t)^{238}Pu$ indicate that—contrary to theoretical expectations—the ratios of the cross sections for population of the $K^{\pi} = 0^+$ excited states to those for population of the ground states are of the same order of magnitude as the ratios for the equivalent (p,t) reactions. (auth)

13568 SEARCH FOR γ-RAYS EMITTED IN THE FORMATION OF A FISSION ISOMER. Benson, D. Jr.; Lederer, C. M.; Cheifetz, E. (Univ. of California, Berkeley). Nucl. Phys.; A201: No. 3, 445-448(1973).

A search for γ-rays preceding isomeric fission in the reaction $^{238}U(\alpha,2n)^{240m}Pu$ yielded negative results. Upper limits are given for the number of unconverted photons per isomer formed. (auth)

Nuclear Theory

Refer also to abstracts 13326, 13385, and 13560.

13569 (AREAEE-148) NUCLEAR STATISTICAL FLUCTUATION PROGRAM (NCFL). Comsan, M. N. H. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Physics Dept.). 1972. 36p. Dep. NTIS (U. S. Sales Only).

A detailed description of the computer program "NCFL" is presented. This program is used for carrying out nuclear statistical fluctuations in terms of Ericson theory. A brief discussion on methods used in extracting various expressions involving in the theory is given. The computer program is written in FORTRAN-IV for the use on the ICL-1905E computer. However it can be used on other computers for which coring storage is not less than 16 K. The complete program listing is included. Listings of sample input and output from the program are given. The author will be grateful for corrections and suggestions for modifications from the users of the program. (auth)

13570 (BARC-635) STUDY OF CLUSTER KNOCK-OUT REACTIONS ON LITHIUM ISOTOPES. Jain, A. K. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 125p. Dep. NTIS (U. S. Sales Only).

The reactions $^6Li(p,pd)$, $^7Li(p,pt)$, and electron elastic scattering on ^6Li were studied using fully antisymmetrized cluster model wave functions. Various approximations were applied within the formalism to evaluate distortion and exchange terms in the ^6Li (p,pd) reaction. The electron elastic scattering data and the quadrupole moment of ^6Li were fitted using cluster model wave functions with proper asymptotic fall off and phenomenological cluster distortions. A similar analysis for the $^7Li(p,pt)$ reaction was performed using the impulse approximation. Comparisons with experimental data were made for each of the reactions. (J.W.R.)

13571 (CONF-720309) SYMPOSIUM ON TWO-NUCLEON TRANSFER AND PAIRING EXCITATIONS, ARGONNE NATIONAL LABORATORY, ILLINOIS, MARCH 20–21, 1972. (Argonne National Lab., Ill.). 1972. Contract W-31-109-eng-38. 419p. Dep. NTIS.

Separate abstracts were prepared for 22 of the 23 papers included. The remaining paper has previously appeared in NSA. (J.W.R.)

For abstracts of individual papers see: 13409, 13446–13449, 13460, 13485–13487, 13515, 13516, and 13572–13582.

13572 (CONF-720309–, pp 41-103) TWO NUCLEON TRANSFER ON DEFORMED NUCLEI. Hintz, N. M. (Univ. of Minnesota, Minneapolis). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Nuclear structure studies of deformed nuclei utilizing two-neutron transfer reactions are surveyed. Sections are included on good deformed nuclei, good transition nuclei, bad transition nuclei, 0/2/4 in-band intensity ratios, odd-A nuclei, and octupole vibrational states. (J.W.R.)

13573 (CONF-720309–, pp 113-58) PAIRING CORRELATIONS AS PROBED IN TWO-NEUTRON TRANSFER REACTIONS. Broglia, R. A. (Univ. of Copenhagen). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The use of two-neutron transfer reactions in studying the dynamical aspects of pairing correlations in nuclear structure is discussed. Topics covered include pairing rotations and vibrations in systems far from closed shells, systems near closed shells, and intermediate situations such as phase transition regions and gapless $J^{\pi} = 0^+$ pair vibrations in deformed nuclei. (J.W.R.)

13574 (CONF-720309–, pp 159-74) DISTORTED-WAVE THEORY FOR TWO-NUCLEON TRANSFER. Bayman, B. F. (Univ. of Minnesota, Minneapolis). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The use of distorted-wave theory for two-nucleon transfer reactions is discussed. The exact evaluation of two-neutron transfer DWBA integrals is examined in detail. (J.W.R.)

13575 (CONF-720309–, pp 175-83) TWO-STEP PROCESSES. Glendenning, Norman K. (Univ. of California, Berkeley). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The importance of higher order processes in particle transfer reactions is discussed. Methods for including higher order processes in calculations are described. (J.W.R.)

13576 (CONF-720309–, pp 184-92) TWO-NUCLEON TRANSFER TO K = O EXCITED BANDS IN DEFORMED NUCLEI. Sorensen, Bent (Univ. of Copenhagen); Ascuitto, R. J. 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Experimental data on (p,t) reactions to K = O excited bands in deformed nuclei have raised the question of whether the conventional theory of quadrupole deformed superfluid nuclei is adequate. By a careful theoretical treatment of the structure as well as the reaction problem, an attempt is made to answer the question. (J.W.R.)

13577 (CONF-720309–, pp 193-201) MULTI-STEP PROCESSES IN (p,t) EXCITATIONS OF PAIR VIBRATIONAL STATES. Udagawa, T.; Tamura, T. (Univ. of Texas, Austin). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The importance of multistep processes in (p,t) reactions to pairing vibrational states is examined. Calculations are performed for the ^{144}Nd(p,t) and ^{158}Gd(p,t) reactions at E_p = 52 MeV using the coupled-channel Born approximation. The results are in good agreement with experimental data. (J.W.R.)

13578 (CONF-720309–, pp 203-31) TWO-NUCLEON TRANSFER REACTIONS IN LIGHT NUCLEI. Hardy, J. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The status of nuclear spectroscopy studies on light nuclei using two-nucleon transfer reactions is surveyed. Some of the successes of two-nucleon transfer reactions in establishing the validity of model calculations for p-, sd-, and fp-shells are outlined. The emphasis is on those properties which can be reliably determined by single-channel zero-range DWBA analyses. Some of the more obvious limitations inherent in such DWBA calculations are pointed out. (J.W.R.)

13579 (CONF-720309–, pp 232-72) ALPHA TRANSFER REACTIONS. Garrett, J. D. (Los Alamos Scientific Lab., N. Mex.). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Possible α-cluster transfer reactions are discussed. The best candidates are the lithium-induced four-nucleon stripping reactions and their inverse pick-up reactions and heavy-ion induced reactions. Selected experimental data is reviewed to determine the degree of direct α-cluster transfer for the various reactions. (J.W.R.)

13580 (CONF-720309–, pp 273-303) TWO-NUCLEON TRANSFER REACTIONS WITH HEAVY IONS. Siemssen, R. H. (Argonne National Lab., Ill.). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

Studies on two-nucleon transfer reactions induced by heavy ions are reviewed. Reaction mechanisms are discussed and methods of analysis are described. Some experimental data for heavy ion reactions on medium-weight nuclei is briefly surveyed. (J.W.R.)

13581 (CONF-720309–, pp 304-19) COHERENT TWO- AND FOUR-PARTICLE EXCITATIONS. Arima, Akito (State Univ. of New York, Stony Brook). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The α-cluster transfer mechanism in nuclear reactions is discussed. Possibilities for finding enhanced cluster effects are described. (J.W.R.)

13582 (CONF-720309–, pp 402-11) QUASI-CLASSICAL TREATMENT OF MULTINUCLEON TRANSFER REACTIONS. Toepffer, Christian (Univ., Frankfurt am Main). 1972.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL (20 Mar 1972).

The use of quasi-classical wave functions in analyzing multinucleon transfer reactions is discussed. Some calculations using the theory are compared with experiment. (J.W.R.)

13583 (FEI–293) CALCULATIONS OF CROSS SECTIONS OF RADIATIVE CAPTURE OF FAST NEUTRONS IN ACCORDANCE WITH THE STATISTICAL THEORY OF NUCLEAR REACTIONS. Dovbenko, A. G.; Ignatyuk, A. V.; Tolstikov, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Tekhnicheskii Institut). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effect of the energy dependence of partial radiative widths, of the energy dependence of level densities, and of the fluctuation of neutron widths on the behavior of fast neutron radiative capture cross sections is investigated. (tr-auth)

13584 (HEDL-TME-71-154) OPTICAL MODEL STUDIES FOR FAST NEUTRON CAPTURE CROSS SECTION CALCULATIONS. MacKellar, A. D.; Schenter, R. E. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1972. Contract AT(45-1)-2170. 37p. (ENDF-160). Dep. NTIS.

A study of recent optical model potentials was performed to test their effect on neutron capture cross section calculations of fission product isotopes. Phenomenological optical potentials of several types were used with real and imaginary well depths and energy dependences varied to measure the sensitivity of capture cross section calculations to these parameters. Consistency with measured total cross section data was also checked. In addition, an equivalent local complex optical potential was calculated from a nonlocal separable complex potential of the Yamaguchi form. (auth)

13585 (INR-P-1408) ON THE ROLE OF THE γ-DECAY OF UNBOUND NUCLEAR STATES IN THE NUCLEON INDUCED REACTIONS. Decowski, Piotr; Grochulski, Witold; Marcinkowski, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1972. 44p. Dep. NTIS (U. S. Sales Only).

The γ-decay of unbound states was included in statistical calculations of cross sections for nucleon induced reactions. The results of calculations were compared with the experimental excitation curves for (n,γ), (p,γ), (p,n), (n,n'), (n,2n) and (n,p) reactions. Good agreement between the experimental data and the theoretical calculations was obtained without use of adjustable parameters. The γ-decay competes successfully with particle emission from high spin unbound states in the energy region above the thresholds of (n,2n) and (n,pn) reactions, increasing significantly cross sections of (n,n') and (n,p) reactions. (auth)

13586 (IPNO/TH-72-30) ENERGY DENSITY FORMALISM AND THE SHELL STRUCTURE OF NUCLEI. Lombard, R. J. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Oct 1972. 14p. (CONF-720933-4). Dep. NTIS (U. S. Sales Only).

From Symposium on present status and novel developments in the nuclear many-body problem; Rome, Italy (19 Sep 1972).

An extension of the energy density formalism is proposed in which the single-particle structure of nuclei is taken into account. The approach is similar to the local density approximation and allows one to describe local mass fluctuations of nuclei. (auth)

13587 (JINR-E2-6697) INTERPRETATION OF HIGH ENERGY INELASTIC INTERACTIONS OF PIONS WITH HEAVY EMULSION NUCLEI. Eliseev, S. M.; Kokhli, Dzh. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 24p. Dep. NTIS (U. S. Sales Only).

An analysis is presented regarding the basic characteristics of secondary particles created in the interactions of pions with heavy emulsion nuclei at the highest accelerator energies available. Calculations were performed on the basis of internuclear cascade model by the Monte Carlo method taking into account the "trailing effect." Emission of slow particles from the excited residual nucleus was calculated after Weisskopf's evaporation theory. The theoretical results were compared with the experimental results at 17.2 GeV and 60 GeV pion interactions. (auth)

13588 (JINR-E2-6706) MONTE CARLO CALCULATIONS OF REACTIONS INDUCED BY HIGH-ENERGY PARTICLES AND RELATIVISTIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Zheregi, F. G.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 50p. Dep. NTIS (U. S. Sales Only).

As a comparative study of calculations by various authors reveals, the intranuclear cascade model which involves evaporation (or more fast decay) of the residual nucleus agrees well with experiment for energies higher than several dozens of MeV. In the high-energy region ($T \gtrsim 0.5$-1 GeV for light nuclei, and $T \gtrsim 3$–5 GeV for heavy nuclei) it is necessary to take account of decreasing of matter density of the target-nucleus due to knocking out of a large number of target constituents by the cascade particles. Interactions of the produced resonances ρ, ω, N* and so on with the nuclear nucleons contribute rather little to the cascade development. At the present time the least known and the most difficult for calculations remain just the high-energy fission of heavy nuclei and the phenomena occurring at the relativistic nuclei collisions. If the fission of the excited residual nuclei is calculated by means of statistical methods and the fission barriers are defined from the phenomenological approach which describes the mean experimental values, then one can obtain a rather good agreement with known experimental data on the cross sections of fission, on multiplicity, on angular and energy distribution of accompanying particles. Calculations for intranuclear cascades initiated by the light incident nuclei d, t, ^{3}He, α agree with experiment, as well. However the experimental information available here for comparison is still poor. The latter concerns very much interactions with heavier bombarding nuclei C, N, O, etc. The cascade-evaporation model which we have developed makes such calculations possible and gives a rather good agreement with experiment. Some observed disagreements are explained by the fact that the model provides a somewhat overestimated number of intranuclear collisions. For the further evolution of this model one needs first of all the more accurate experimental data. (auth)

13589 (JINR-E2-6765) DISPERSION CALCULATION OF THE REAL PART OF THE FORWARD π ^{4}He ELASTIC SCATTERING AMPLITUDE. Dubichka, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 16p. Dep. NTIS (U. S. Sales Only).

Once-substracted forward dispersion relation (FDR) is used to calculate the real part of the elastic pion–helium forward scattering amplitude. The calculated real part of the scattering amplitude is compared with the new existing experimental data, as found by the optical theorem and the extrapolation of the angular distribution of the forward direction. (auth)

13590 (JINR–E4-6630) STUDY OF HIGHLY EXCITED STATES BY MEANS OF A MODEL WITH MULTIPOLE AND SPIN-MULTIPOLE FORCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 28p. Dep. NTIS (U. S. Sales Only).

Basic equations of a suggested model are derived which are used for the description of the structure of highly excited nuclear states. The interaction between nucleons is represented as the sum of the average nuclear field, the interaction leading to superconducting pairing correlations and the multipole and spin-multipole forces. The interaction of quasiparticles with phonons responsible for the complication of the structure of states with increasing excitation energy is taken into account. (auth)

13591 (JINR–E4-6663) NONROTATIONAL STATES OF SOME TRANSCURIUM ELEMENTS. Ivanova, S. P.; Komov, A. L.; Malov, L. A.; Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 26p. Dep. NTIS (U. S. Sales Only).

The lowest nonrotational states of nuclei in the region $250 \leq A \leq 261$ are investigated on the basis of the semi-microscopic approach. The energies and the structure of the ground and excited states of odd-A, doubly even, and doubly odd nuclei and the reduced probabilities of E2- and E3-transitions to the vibrational states of doubly even nuclei are presented. (auth)

13592 (JINR–E4-6783) POSITIVE ENERGY BOUND STATES OF NONLOCAL SEPARABLE POTENTIALS. Beregi, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 16p. Dep. NTIS (U. S. Sales Only).

The behavior of the positive energy bound states of the nonlocal separable potentials in the many-channel case is investigated. It is shown that these states become resonances when the coupling between different channels is switched on. The energy-dependence of the phase shift for different cases is presented. (auth)

13593 (JINR–P4-6719) INTRINSIC-EXCITATION-COUPLED-TO-ROTATOR-MODEL (IECRM) FOR ODD-MASS NUCLEI. Mikhailov, I. N.; Karadzhov, D.; Shaker, M. O. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

A new approach to the low-lying (rotational) spectra of the odd-mass deformed nuclei is presented. Starting from the many-body Schroedinger equation one reaches the equations of a model, called "intrinsic-excitation-coupled-to-rotator-model" (IECRM). To do this we use the knowledge concerning ground-band states and energies in neighboring even-even nuclei and apply a projection technique. It is shown IECRM is a generalization of the well-known "rotator-model" and gives, at the same time, a more adequate procedure when one works (as usual) in a limited basis of single-(quasi)-particle states. As a consequence it follows that the core parameters of an odd-nucleus are considerably changed in comparison with the corresponding quantities of the even-even neighboring nuclei. (auth)

13594 (LUSY–7208) SMALL ANGLE SCATTERING OF HIGH ENERGY PHOTONS ON HEAVY NUCLEI (DELBRUECK SCATTERING, PHOTON SPLITTING). Jarlskog, G.; Joensson, L.; Pruenster, S.; Schulz, H. D.; Willutzki, H. J.; Winter, G. G. (Lund Univ. (Sweden). Dept. of Physics). 1972. 35p. Dep. NTIS (U. S. Sales Only).

During 1970-1972 an experiment has been carried out at the DESY electron synchrotron with the aim to study Delbrück scattering which is the elastic scattering of a photon in the Coulomb field of nuclei via virtual electron positron pairs. The incoming photon converts into a virtual electron positron pair, which is scattered twice in the static Coulomb field of the nucleus and subsequently annihilates into an outgoing photon. The Delbrück cross section at high energy, high Z and a few MeV/c momentum transfer has been found to be a factor of 3 to 5 smaller than calculated in the lowest nonvanishing order of perturbation theory. This drastic reduction is due to a special kind of higher order corrections, called Coulomb correction, which fully accounts for the observed difference. Thus the result is that perturbation expansion gives correct results provided the calculation is extended to high enough orders. There is strong evidence for the photon splitting process to be present in our data. The cross section deduced from these data is of the expected order of magnitude, but at present there are no precise theoretical numbers to compare with. Experimentally the next step should be to do a coincidence experiment on the photon splitting process and from our experience such an experiment is feasible. Finally one has to admit, that wherever one tries to check QED once more it comes out as an astonishing good theory. (auth)

13595 (ORO–4317-10) EVIDENCE FOR A STRONG THREE-BODY FORCE IN THE TRITON. Technical Report No. 73-048. Brayshaw, D. D. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct 1972. 20p. (CONF-720819–18). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA (28 Aug 1972).

Existing data for the charge form factors of ^{3}He, ^{3}H and some assumptions are employed to construct a model of the triton wave function. Given this wave function, the Schroedinger equation may be trivially solved for the effect local potential. The discrepancy between this potential and those predicted by typical pair-interaction models in the domain where all three particles are close together appears to provide evidence for a strong attractive three-body force. (auth)

13596 BETA-RAYS FROM POLARIZED NUCLEI AND PSEUDO-TENSOR CURRENT. Igarashi, Masataka (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1237-43(Oct 1972).

The general expression for the angular distribution of the electron and neutrino is given in the case of the allowed beta decay of polarized nuclei under the assumption of G-parity nonconservation. Explicit formulas are derived for neutron beta decay and for the pure Gamow–Teller transition. It is pointed out that the magnitude of the pseudotensor coupling constant can, in principle, be obtained by measuring the angular distribution of the beta particles with respect to the initial nuclear polarization axis. (auth)

13597 INTERMEDIATE STRUCTURE IN ENERGY SPECTRA. Izumo, K. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1204-20(Oct 1972).

Strong peaks observed in the energy spectrum of the ^{27}Al(^{3}He,p)^{29}Si reaction in the continuum excitation energy range are interpreted as an intermediate structure appearing in the energy spectrum. The intermediate structure comes from a restriction of the degrees of freedom of the motion in excitations of the residual nucleus. It is pointed out that there will be interferences among energy spectra, excitation curves, and angular distributions if such an intermediate structure is observed in the energy spectra as well as in the excitation curves. It is also shown that the intermediate structure is one step of a series of sequential reaction processes based on a new time-dependent treatment of nuclear reactions. (6 figures) (auth)

13598 APPROXIMATION METHOD BASED ON IDENTITIES FOR CALCULATING NUCLEAR MATRIX ELEMENTS. II. TRUNCATION AND SIMULATION. Fujita, Jun-Ichi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1221-36(Oct 1972).

A general mathematical procedure has been discussed as to how to apply the projection operator formalism to the study of nuclear matrix elements. A theoretical foundation for conventional nuclear models is given on the basis of the projection operator formalism, and approximate formulas convenient for practical calculations of nuclear matrix elements are provided. Various existing theories are reexamined from this standpoint. (auth)

13599 FINITE NUCLEAR SIZE EFFECTS IN ALLOWED β-DECAY. Wilkinson, D. H. (Univ. of Washington, Seattle); Marrs, R. E. Nucl. Instrum. Methods; 105: No. 3, 505-8(1972).

A formal definition is put forward for the phase-space factor for allowed β-decay taking into account finite nuclear size effects. A simple and accurate parameterization valid for $Z \leq 40$, of the Behrens–Jänecke electron wavefunctions, is given and is used to evaluate the finite size effects analytically in a simple formula valid for high energy transitions where the corrections have practical significance. (auth)

13600 INVESTIGATION OF NUCLEAR REACTION MECHANISMS. I. Ol'khovskii, V. S.; Tsekhmistrenko, Yu. V.; Chinarov, V. A. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 1012-21(Jun 1972). (In Russian).

The method of intermediate structure is generalized for the case of discrete states describing the three-momentum particle motion (in a laboratory system). As a consequence, various mechanisms of nuclear reactions can be described within the framework of a single method, namely, quasi-stationary decay caused by formation of a long-lived intermediate compound system and a "direct" mechanism leading to a sharp asymmetry of the angular distribution with respect to 90°. A strict additivity of the contributions of

both mechanisms is shown. Evaluation of the "smooth" summand and natural generalizations of the method developed (in particular, an account of four-momentum intermediate states) are discussed. (1 figure) (auth)

13601 $\Delta N = 2$ MIXING BETWEEN ONE-PARTICLE STATES IN DEFORMED ODD NUCLEI. Andersen, B. L. (Niels Bohr Inst., Copenhagen). Nucl. Phys.; A196: No. 3, 547-60(1972).

The presently available experimental evidence concerning $\Delta N = 2$ mixing is analyzed and compared with theoretical predictions based on a deformed Woods–Saxon potential with multipole deformations of order 2, 4, and 6. (auth)

13602 VISCOSITY COEFFICIENTS FOR NUCLEAR FISSION. Schirmer, J.; Knaak, S.; Suessmann, G. (Univ., Munich). Nucl. Phys.; A199: No. 1, 31-44(1973).

An expression for the energy dissipation during nuclear fission (or heavy-ion) processes has been derived in the first-order viscosity approximation. Irrotational flow and incompressibility have been assumed in order to calculate a quadratic form for the heat production, microscopically interpreted as particle-hole excitations. A modified algebraic parameterization of the nuclear shape has been found, which is more suitable than the usual ones to describe shapes close to spheroids (or spheres). Furthermore, it allows for analytical solutions of the fluid equations for one degree of freedom (and in special cases of the nuclear shapes, for all degrees). (auth)

13603 STATISTICAL TEST FOR INTERMEDIATE STRUCTURE. Baudinet-Robinet, Y.; Mahaux, C. (Univ., Liege). Phys. Lett.; 42B: No. 4, 392-4(25 Dec 1972).

A new statistical test, based on the number and length of the runs up and down, is proposed to identify an intermediate structure. It is applied to the examples $^{206}Pb(n,n)$ and $^{115}In(n,\gamma)$. (auth)

13604 ELECTROMAGNETIC STRUCTURE OF NUCLEONS. Fowler, G. N. (Exeter Univ., Eng.). Essays Phys.; 4: 1-41 (1972).

Various possible models are considered which could be used to draw conclusions concerning the structure of nucleons from the stream of available experimental results. From one such model one could expect the nucleon to behave in high energy inelastic collisions somewhat like a collection of independent entities. These scattering processes are discussed with particular reference to a composite model. A brief account of the Stanford linear accelerator (S.L.A.C.) is given. The basic formulae used in the analysis of experiments on elastic scattering on protons and deuterons are recapitulated and used to extract the basic quantities, which are then compared with experiment. Experimental results are described. A theoretical analysis of the results in terms of the meson cloud and the composite pictures are given, emphasizing the seminal pieces of information which help to distinguish between these models. The experimental results on inelastic processes at very high energy and at large angles are considered, demonstrating the way in which the data suggest a composite model. A brief survey is given of other data bearing on the structure of nucleons arising from a study of high energy proton–proton elastic scattering. (UK)

13605 EFFECTS OF INTERNAL STRUCTURE OF THE α-PARTICLE IN THE α-CLUSTER MODEL. Turner, James R.; Jackson, A. D. (Univ. of Copenhagen). Nucl. Phys.; A192: No.1, 200-8(1972).

The significance in the α-cluster model of the internal structure of the α particle, as manifested by the inelastic thresholds observed in $\alpha-\alpha$ scattering, is discussed. It is shown that the inclusion of these effects leads to a decrease in binding energies in α-cluster model calculations. For the three α-system (^{12}C) a simple model calculation gives a conservative estimate of 0.43 MeV for this decrease in binding energy. An estimate of the effects of α-particle internal structure for heavy α-cluster nuclei is also given via a lowest-order α-matter calculation. (auth)

13606 MULTIPLE-REACTION CORRECTION TO THE CAPTURE CROSS SECTION. Devaney, J. J. (Los Alamos Scientific Lab., NM). Phys. Rev. Lett.; 29: No. 23, 1567-9(4 Dec 1972).

The multiple-reaction correction of Halpern, Drake, et al., to neutron radiative cross-section measurements is shown to be important also below 14 MeV, with the consequence that previously measured uncorrected (or unrestricted to first-chance capture only) (n,γ) cross sections above the first level are in error, being from about 1% to a factor of more than 10 too high. (auth)

13607 IWAMOTO–YAMADA CLUSTER EXPANSION: ITS STRUCTURE AND RENORMALIZATION. Ristig, M. L. (Univ., Cologne); Clark, J. W. Nucl. Phys.; A199: No. 2, 351-68(1973).

The structure of the Iwamoto–Yamada expansion of the correlated energy expectation value for a homogeneous Fermi medium is analyzed. By the introduction of induced two-, ... n-body potentials, the n-body cluster, $2 \leqq n \leqq A$, is decomposed into a proper n-body part and m-body combination terms, $2 \leqq m \leqq n$. Explicit formulas are presented through the five-body case. Examination of these structural results leads to a factorization theorem for the total weight function associated with a given (diagonal) induced-potential matrix element and then to a renormalization of the complete energy expansion and a renormalization of the single-orbital weight function. The definition of the latter function is extended in such a way as to exploit previous findings; thereupon, a functional of this generalized distribution analogous to the grand-canonical partition function of classical statistical mechanics is brought into play, and the renormalized theory is recast in a compact (and possibly more general) variational form. Specific renormalized theories emerge upon specification of the two-, ... n-body correlation operators, interesting prescriptions being supplied by the Jastrow, unitary operator, and the Brueckner–Bethe–Goldstone schemes. (auth)

13608 ANTICENTRIFUGAL STRETCHING IN ^{20}Ne. Lee, H. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Cusson, R. Y. Phys. Rev. Lett.; 29: No. 22, 1525-7(27 Nov 1972).

A variation-after-projection Hartree–Fock calculation shows that the rms radius of ^{20}Ne decreases with increasing spin in the ground-state band. This decrease is consistent with the significant reduction in α width between the 6^+ and the 8^+ states. It also leads to the theoretical B(E2) values reproducing the measured values exceedingly well. (auth)

13609 COHERENT DESCRIPTION OF DEFORMED NUCLEI USING A NONLINEAR LEAST SQUARE METHOD APPLIED TO THE INVERSION OF THE ENERGY MATRIX. Thomann, J. (CNRS, Strasbourg); Piepenbring, R. J. Phys. (Paris); 33: No. 7, 613-23(Jul 1972). (In French).

In the frame of the unified model, a new approach is given for a coherent description of deformed nuclei. The observed energies are considered as eigenvalues of the Hamiltonian of the model where a limited number of parameters is introduced. This leads to a nonlinear least square fit for the parameters, from which interesting information is obtained concerning the nuclear structure. (France)

13610 FLUCTUATION CHARACTERISTICS OF THE LIGHTEST NUCLEI. Toktarov, K. A.; Sharapov, N. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 69-72(1972). (In Russian).

Radius fluctuations were determined for deuterium and tritium. The emission cross sections of high energy deuterons in nuclear fission were calculated on the basis of the fluctuation concept of nuclear matter. (tr-auth)

13611 PROCEEDINGS OF THE INTERNATIONAL SCHOOL ON NUCLEAR REACTIONS. Conference Held at Predeal, Romania, July 9–21, 1970. Corciovei, A. (ed.). Bucharest; Institute for Atomic Physics (1970). 479p. (CONF-700727).

The 11 lectures and the 13 communications included are listed by title in NSA. (J.W.R.)

For abstracts of individual papers see: 13390, 13477, 13501, 13525, 13556, 13557, and 13612–13629.

13612 REACTION MECHANISM FOR PROTON SCATTERING ON MEDIUM WEIGHT NUCLEI. Berinde, Alexandru (Inst. for Atomic Physics, Bucharest). pp 1-15 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13613 PARTICLE SPECTROSCOPY WITH ISOBARIC ANALOGUE RESONANCES. von Brentano, Peter (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 16-76 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13614 NUCLEAR REACTION MECHANISMS: A CRITICAL DESCRIPTION. Cindro, N. (Rudjer Boskovic Inst., Zagreb). pp 77-150 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13615 SINGLE NUCLEON TRANSFER REACTIONS. Elbek, Bent (Univ. of Copenhagen). pp 151-84 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).

From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13616 NUCLEAR STRUCTURE IN THE s–d SHELL. Endt, P. M. (State Univ., Utrecht). pp 185-218 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13617 RECENT ADVANCES IN THE STUDY OF FISSIONING ISOMERS AND ASSOCIATED PHENOMENA. Ferguson, A. T. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 232-73 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13618 SHORT RANGE CORRELATIONS. Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). pp 274-303 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13619 PARITY VIOLATING EFFECTS IN NUCLEI. Gari, M.; Zabolitzky, J. G.; Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). pp 304-19 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13620 ISOMERIC FISSION AND NUCLEAR STRUCTURE INVESTIGATIONS. Vilcov, N. (Inst. for Atomic Physics, Bucharest). pp 320-34 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13621 INTERACTIONS INCLUDED IN THE STRIPPING THEORY. Dumitrescu, Ovidiu (Ruhr-Univ., Bochum, Ger.). pp 353-71 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13622 CLASSIFICATION OF THE SPIN–ISOSPIN FUNCTIONS OF THE IDENTICAL NUCLEONS SYSTEM. Grama, N. (Inst. for Atomic Physics, Bucharest). pp 385-91 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13623 ACCURACY OF JWKB APPROXIMATION IN PROBLEMS INVOLVING THICK POTENTIAL BARRIERS. Ixaru, L. (Inst. for Atomic Physics, Bucharest). pp 406-14 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13624 PROTON REMOVAL PROCESSES AND THE HOLE STRUCTURE OF ATOMIC NUCLEI. Lipperheide, R. pp 415-22 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13625 MULTI-NUCLEON TRANSFER REACTIONS. Rotter, I. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 423-33 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13626 SOLUTION OF BETHE–GOLDSTONE TYPE EQUATIONS IN OSCILLATOR AND WOODS–SAXON SHELL MODEL. Schlitter, J.; Gari, M. (Ruhr-Univ., Bochum, Ger.). pp 434-40 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13627 (d,p) REACTION ON DEFORMED NUCLEI. Schulz, H.; Wiebicke, H. J. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 441-53 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13628 APPLICATIONS OF A GENERALIZED DWBA MODEL. Schulz, H.; Wiebicke, H. J. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 454-8 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13629 SOME RECENT ANALYSES OF HIGH-ENERGY ELECTRON–NUCLEUS SCATTERING. Toepffer, Christian (Univ., Frankfurt am Main). pp 459-69 of Proceedings of the International School on Nuclear Reactions. /Corciovei, A. (ed.). Bucharest; Inst. for Atomic Physics (1970).
From International school for theoretical nuclear physics; Predeal, Romania (9 Jul 1970). See CONF-700727.

13630 PARTICLE-WAVE AMBIGUITIES IN THE INTERPRETATION OF HEAVY-ION REACTIONS. Siemens, P. J. (Niels Bohr Inst., Copenhagen); Becchetti, F. D. Phys. Lett.; 42B: No. 4, 389-91(25 Dec 1972).

The relations between the partial-wave scattering amplitudes in l space and the reaction cross section angular distributions are derived in the limits of classical and diffractive scattering. It is shown that a measurement of the angular distribution of a "quasi-elastic" heavy-ion reaction does not permit an unambiguous inference of the partial-wave amplitudes of the reaction, even for large l. The ambiguities are illustrated with DWBA calculations. (auth)

13631 MICROSCOPIC CALCULATION OF THE IMAGINARY POTENTIAL IN HEAVY-NUCLEUS SCATTERING. Alexander, D. R.; Malik, F. B. (Indiana Univ., Bloomington). Phys. Lett.; 42B: No. 4, 412-14(25 Dec 1972).

The imaginary part of the optical potential for the scattering of one heavy nucleus by another is computed from two-nucleon phase shifts by using an extended version of Harada–Oda theory, and is found to be volume-like, L dependent, and energy dependent. (auth)

13632 AUTO-IONIZATION IN ELECTRON-CAPTURE DECAY. Law, J.; Campbell, J. L. (Univ. of Guelph, Ont.). Nucl. Phys.; A199: No. 3, 481-503(1973).

The model presented previously for auto-ionization in β-decay is extended to deal with orbital-electron capture. Available experimental data are reviewed critically in order to effect a useful comparison with theoretical predictions. The need for new data is emphasized. (auth)

13633 MANY-QUASIPARTICLE COMPONENTS OF THE WAVE FUNCTIONS OF NEUTRON RESONANCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 42B: No. 4, 409-11(25 Dec 1972).

The magnitude of many-quasi-particle components of the wave functions of highly excited states is discussed. Two possible cases are considered; all the components of the wave functions of neutron resonances are small; these functions contain large many-quasi-particle components. The latter is demonstrated by a model which takes into account quasi-particle–phonon interactions. Some ways of experimentally observing large many-quasi-particle components are discussed. (auth)

13634 STATISTICAL PROPERTIES OF EXCITED NUCLEI AND THE DETERMINATION OF THE GROUND-STATE SHELL CORRECTION ENERGIES. Ramamurthy, V. S.; Kapoor, S. S. (Bhabha Atomic Research Centre, Bombay). Phys. Lett.; 42B: No. 4, 399-403(25 Dec 1972).

It is shown that the ground-state shell correction energies of nuclei can be obtained from a study of the high-temperature behavior of their thermodynamic properties without recourse to Strutinsky's smearing procedure. (auth)

13635 SUB-COULOMB (d,p) STRIPPING THEORY INTO THE CONTINUUM. Baur, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Trautmann, D. Nucl. Phys.; A199: No. 1, 218-24(1973).

A method of calculating sub-Coulomb (d,p) stripping into the continuum is formulated. This process interferes with the pure Coulomb break-up. The only nuclear quantity which enters into the expressions is the phase shift for neutron-target scattering. Some typical calculations are performed where the neutron-target

scattering phase shift is calculated from an optical-model potential. A comparison with experimental results shows good agreement. (auth)

13636 ANGULAR CORRELATIONS IN THREE-BODY REACTIONS. Lindner, A. (Univ., Hamburg). Nucl. Phys.; A199: No. 1, 110-14(1973).

The differential cross section $d\sigma/d\Omega_1 d\Omega_2 dE$ for reactions of the type $a + A \rightarrow B + b_1 + b_2$ is given in terms of Biedenharn's triple correlation functions and the elements of the transition matrix, which may be given in the channel spin representation or in the j-representation. The particles involved may have arbitrary spin. (auth)

13637 NUMBER CONSERVING QUASI-PARTICLE CORRELATIONS IN SUPERCONDUCTING NUCLEI. Hernandez, E. S. (Univ. of Buenos Aires); Plastino, A. Lett. Nuovo Cim.; 5: No. 8, 630-4(21 Oct 1972).

In order to satisfy a conservation law in a many-body system, special correlations between different states must exist. In the particular problem considered, these states are seen to be the conjugated 4-q.p. ones. The projection + intermediate basis + variational procedure provides a way to include these correlations as corrections to the BCS results. (W.D.M.)

13638 EFFECT OF NONLOCAL FORCES ON THE INTEGRATED CROSS-SECTION OF PHOTONUCLEAR REACTIONS. Borsig, M. V. (Univ., Munich); Weigel, M. Nuovo Cim.; 12A: No. 4, 1080-6(21 Dec 1972).

The modification of the dipole sum rule for the nonlocal Tabakin potential is calculated in second-order perturbation theory. The included correlations cause an increase of about 60% for the value of the anomaly compared to the outcome of the independent-particle model. (auth)

13639 SIMPLE RELATION INVOLVING THE E2 TRANSITION PROBABILITIES OF NEIGHBOURING DOUBLY EVEN NUCLIDES. Ross, C. K.; Bhaduri, R. K. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A196: No. 2, 369-88(1972).

We consider, for doubly even nuclei, the excitation energy E_2 and the reduced electric quadrupole transition probability B(E2) between the ground state and first excited 2^+ state. For a nucleus (N,Z), the quantity $[E_2 B(E2)]^{-1}$ is denoted by F(N,Z), and it is shown, on the basis of a microscopic model, that $F(N,Z) + F(N+2, Z+2) - F(N,Z+2) - F(N+2, Z) \approx 0$, excepting in certain specified regions. The consistency of the above difference equation is tested with the available experimental data. A few predictions of unmeasured B(E2) values are also made to illustrate the possible use of this approach. (auth)

13640 MICROSCOPIC FORM FACTORS FOR TRANSFERS BETWEEN HEAVY IONS. Bonche, P.; Giraud, B. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A199: No. 1, 160-8(1973).

Static cluster wave functions are constructed by translations of shell-model wave functions. Waves in the continuum are expanded on this cluster basis. A DWBA transition amplitude is derived, where the form factor is given by a microscopic formula. (auth)

13641 THREE-NUCLEON PROBLEM WITH A POTENTIAL CONTAINING A REPULSIVE CORE. Kharchenko, V. F.; Shadchin, S. A. (Inst. of Theoretical Physics, Moscow). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 267-78(Feb 1972). (In Russian).

On the basis of the Faddeev formalism by using a separable representation of Hilbert–Schmidt for a two-particle t matrix, there is considered the three-nucleon problem with a pair local interaction taking into account repulsion at small distances. The problem is reduced to solving a system of integral equations for functions depending only on one variable. For a potential with an infinite repulsive core and attractive part in a form of a square well, the triton binding energy and neutron–deuteron scattering length are calculated. The parameters of the pair potential are determined from the data on the interaction of two nucleons with the nucleon energies in a range of 0 to 400 MeV (in the laboratory system). (5 tables) (auth)

13642 BETA TRANSITIONS IN THE MODEL OF NONAXIAL ODD NUCLEI. Kashuba, I. E.; Ovcharenko, V. I. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 315-23(Feb 1972). (In Russian).

Matrix elements and comparative decay periods for allowed and first-forbidden β transitions are calculated in the framework of the model of nonaxial odd nuclei. Numerical calculations and comparison with experiment are carried out for the first β transitions $Dy^{165} \rightarrow Ho^{165}$ and $Lu^{177} \rightarrow Hf^{177}$. (1 table) (auth)

13643 TRANSFORMATION OF BREMSSTRAHLUNG PHOTONEUTRON DATA TO DATA CORRESPONDING TO MONOCHROMATIC GAMMA EXCITATION. Thies, H. H.; Barrett, R. F.; Lee, F.; (and others) (Univ. of Western Australia, Nedlands). Aust. J. Phys.; 25: No. 4, 361-6(Aug 1972).

The 4π-integrated neutron spectrum, neutron mean energies, and related functions in photoneutron experiments can be coarsely measured with a multi-BF_3-counter neutron detection system using bremsstrahlung. It is shown here how the bremsstrahlung photoneutron data can be used to calculate the equivalent data that correspond to an idealized experiment using monochromatic γ-rays. Simple formulae are derived which permit an estimate to be made of the accuracy of the transformed neutron data. (auth)

13644 CROSS SECTIONS AND SPECTRA OF PARTICLES RODUCED IN PROCESSES WITH REACTOR ANTINEUTRINO. Mikaelyan, L. A.; Fayans, S. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 15: No. 5, 975-80(May 1972). (In Russian).

The cross sections and final state particle spectra for various reactions induced by antineutrinos from a nuclear reactor and from β-decay of ^{8}Li were calculated. The dependences of the calculated quantities on the decay time are given. (auth)

13645 COUPLING OF THE SPIN-DIPOLE MODE WITH THE DIPOLE OSCILLATIONS. E1 RADIATIVE WIDTHS OF ISOBARIC ANALOG STATES IN ^{207}Pb AND ^{209}Bi. Tanaka, Yasutoshi; Ikeda, Kiyomi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 840-57(Sep 1972).

The coupling of the spin-flip dipole mode with the dipole oscillation is studied through the analysis of photoabsorption cross sections in light nuclei and also E1 radiative widths from isobaric analog states in heavy ones. It is shown that this coupling is reasonably understood by the central force and the tensor force, where the latter works additively to the former. The role of the two-body spin-orbit force has only a minor role for this coupling, for the main coupling terms of this force vanish so long as the shell model wave functions are assumed. The anomalously large E1 radiative width of the isobaric analog state in ^{209}Bi, which is deduced from the ^{209}Bi $(e,e'p)^{208}$Pb reaction at Tohoku University, cannot be explained from the studies. However, the results are consistent with the value obtained from the ^{208}Pb$(p,\gamma_0)^{209}$Bi reaction at the State University of New York at Stony Brook. (auth)

13646 NUCLEAR STRUCTURE THEORY. Irvine, J. M. International Series of Monographs in Natural Philosophy. Oxford; Pergamon (1972). 478p.

The subject is dealt with in four parts: nuclear phenomenology (elementary particles, the two-nucleon system, nuclear masses and charges, nuclear shapes and sizes, nuclear spectroscopy); the nuclear many-body problem (perturbation formalism, nuclear matter and approximate reaction matrices, ground states of spherical nuclei (closed shells), open-shell nuclei, Thomas-Fermi theory, Landau-Migdal theory); nuclear models (the liquid-drop model, the shell model, transitions and moments, nuclear correlations, deformed nuclei, the unified model); the technology of nuclear structure theory (occupation number representation and graphology, single particle wave equations, angular momentum, two-body matrix elements, applications of group theory to nuclear structure, scattering theory). (UK)

13647 POSSIBLE MEANS OF STUDYING THE FISSION BARRIER VALUE IN THE DIRECT TYPE REACTIONS BETWEEN COMPOUND NUCLEI. Kalinkin, B. N.; Permyakov, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; B3: No. 4, 493-8(1972). (In Russian).

The question of which experiments provide the simplest way of obtaining information on the fission barrier for arbitrary nuclei (not only fissioning) is studied. With this aim in view it is suggested to use the form of the mass distribution of the fission fragments and the model developed by the authors, which is based on the inelastic shock mechanism. (auth)

13648 CALCULATIONS ON ELASTIC MAGNETIC-DIPOLE MOMENT TRANSITIONS IN ^{31}P. Sinha, B. B. P. (Univ. of Toronto). Lett. Nuovo Cim.; 5: No. 15, 1011-15(9 Dec 1972).

An empirical approach to DWBA shell model calculations for elastic multipole transitions in electron scattering is discussed. The method consists of performing single-particle calculations of the relevant elastic multipole transitions, of employing a suggestive technique of normalizing as the momentum transfer goes to zero, and of incorporating the distorted-wave feature from known experimental results. Sample calculations are performed for the M1 cross sections of ^{31}P at 250 and 400 MeV incident energies. (JWR)

13649 CONTRIBUTION OF NUCLEON–TRITIUM CHANNEL TO THE O^+ STATE OF FOUR PARTICLES. Narodetskii, I. M.; Lyakhovitskii, V. N.; Gal'pern, E. S. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 306-10(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 431-5(5 Oct 1972).

The cluster approximation "4 = 3 + 1" in the integral equations for four particles is discussed. (LTW)

13650 DIAGRAM K-MATRIX APPROACH TO $p\alpha$ SCATTERING. Baryshnikov, A. G.; Blokhintsev, L. D.; Safronov, A. N.; Turovtsev, V. V. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 294-6(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 414-17(5 Oct 1972).

The single-channel case of pure elastic scattering of nonrelativistic spinless particles ($A + x \rightarrow A + x$) is considered theoretically. Then these considerations are applied to large-angle $p-\alpha$ elastic scattering below the α-particle disintegration threshold. The theoretical differential cross sections are compared with experimental results for $p-\alpha$ scattering at a proton energy of 20.62 MeV. (LTW)

13651 CORRECTIONS TO THE GOLDBERGER–TREIMAN RELATION FOR THE $^3H-^3HE$ TRANSITION. Jarlskog, C. (CERN, Geneva); Yndurain, F. J. Nuovo Cim.; 12A: No. 3, 801-12(1 Dec 1972).

The correction to the Goldberger–Treiman relation for the $^3H-^3He$ transition due to the deuteron–nucleon break-up mechanism was calculated. The magnitude of the correction to the residue of the pion pole is found to be considerable. (auth)

13652 STUDY OF INTERMEDIATE NUCLEAR RESONANCES BY NONLOCAL SEPARABLE POTENTIALS. Pisent, G. (Univ., Padua); Ahmad, S. S. Nuovo Cim.; 12A: No. 3, 665-82(1 Dec 1972).

It is well known that if one considers the possible excitation of the internal degrees of freedom of the target in the description of a nucleon–nucleus scattering process, some typical effects of the coupling between channels, like threshold effects and compound resonances, are found. Different kinds of interactions may be employed in this context provided that they possess tensorial properties able to couple the elastic and inelastic channels together. In this context the use of nonlocal separable potentials, whose remarkable increasing importance in the two- and three-body description of nuclear reactions is well known, is examined. The model is outlined in its general form, and then the potential, compound and quasi-compound resonances are analyzed under some restrictive conditions. A numerical example is given as a particular application. (auth)

13653 ASYMPTOTIC FORM OF THREE-PARTICLE WAVE-FUNCTIONS AND THE CROSS SECTIONS. Newton, R. G. (Univ., Montpellier, France). Ann. Phys. (N. Y.); 74: No. 2, 324-51(Dec 1972).

The asymptotic behavior of three-particle wave functions in the coordinate representation is examined as all three particles move toward infinity. Both the wave function for a particle incident on a bound state and that for three free incident particles are investigated. The results are expressed in terms of cross sections, and they lead to a clean separation of the double-scattering terms from the "true" three-particle scattering amplitude. In addition, the relevant reciprocity theorems are derived from time-reversal invariance. (auth)

13654 VALIDITY OF THE MANY-BODY APPROXIMATIONS IN SPHERICAL NUCLEI. Mustafa, S. M. East Lansing, MI; Michigan State Univ. (1972). 105p. University Microfilms Order No. 72-30,018.

Thesis.

Reduced transition probabilities B(E2), and spectroscopic factors S_j for stripping (d,p) reactions are calculated in the quasi-boson approximation (QBA), Random Phase approximation (RPA), Tamm–Dancoff approximation (TDA), and improved Random Phase approximation (IRPA). The effect of the Pauli principle on the $J = 0$ pairs is shown to be negligible, while it is not for $J \neq 0$ pairs. The effects of these approximations on the B(E2) and S_j systematics are studied by comparing the averages of the absolute deviations from experimental values for each approximation. These studies have been carried out for a large number of spherical nuclei. The problem is formulated by using double-time Green's function techniques. (Diss. Abstr. Int., B)

13655 QUALITATIVE THEORY OF PION SCATTERING BY NUCLEI. Bethe, H. A. (Cornell Univ., Ithaca, NY). Phys. Rev. Lett.; 30: No. 3, 105-8(15 Jan 1973).

The requirement of unitarity, together with the theory of the refractive index, puts a limit on the wave number of a pion (of given energy) in nuclear matter (of given density). A paradox in the conventional theory of pion scattering by complex nuclei is thereby avoided. (auth)

13656 NUCLEAR ISOBAR CONFIGURATIONS. Arenhoevel, H. (Max-Planck-Institut fuer Chemie, Mainz); Weber, H. J. Springer Tracts Mod. Phys.; 65: 58-91(1972).

It is conceivable that during a small fraction of its lifetime in the nucleus a proton or neutron stays in one of its excited states, thus giving rise to isobar configurations in nuclear wave functions. Recent work on the construction, application and possible tests of such isobar admixtures in the short-range nuclear structure area is reviewed. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Confinement and Heating

Refer also to abstract 13749.

13657 (AD–744230) TURBULENT HEATING OF PLASMAS BY STREAMING INSTABILITIES. Final Scientific Report. Drummond, W. E.; Thompson, J. R.; Sloan, M. L.; Wong, H. V. (Austin Research Associates, Inc., Tex.). Jun 1972. Contract F44620-70-C-0087. 73p. (ARA–80; AFOSR-TR–72-1200). NTIS.

Progress toward understanding the development and nature of turbulence generated from a source of free-streaming energy within a collisionless plasma is discussed. The initial evolution of microturbulence, during which the electron drift energy is very efficiently converted to electron thermal energy and ion sloshing energy, is now largely understood. The authors have also developed a model of the late-time turbulence evolving in a driven toroidal confinement device. Several investigations have also been completed of the generation of plasma turbulence via the decay of large-amplitude waves. Finally, the authors have initiated research on the feasibility of heating fusion plasmas via the injection of energetic beams of relativistic electrons. (auth)

13658 (AD–744652) THEORY OF TURBULENT PLASMA HEATING BY ANOMALOUS ABSORPTION OF MAGNETOSONIC WAVES. McBride, J. B.; Ott, Edward; Wagner, C. E. (Naval Research Lab., Washington, D. C.). Jun 1972. 18p. (NRL-MR–2450). NTIS.

Theory and computer simulation experiments have shown the potential importance of the fluid-like, modified two-stream instability as an ion heating mechanism in low-beta plasmas. In order to take advantage of the strong ion heating it can produce, the authors consider inducing the instability with large-amplitude waves in order to convert the energy in the wave fields into ion thermal energy. Since the instability is driven by relative electron–ion drifts across a magnetic field B_0, and has a frequency comparable to the lower hybrid frequency (ω_{LH}) a natural choice for the driver wave is a magnetosonic wave that propagates across B_0 near the Alfven speed. As a specific example, the authors demonstrate that for the parameters of the Princeton ST-Tokamak it is theoretically possible to achieve thermonuclear temperatures by anomalously absorbing these waves via the modified two-stream instability. (auth)

13659 (JINR–E4-6716) ANOMALOUS HEATING OF DENSE PLASMA BY LASER RADIATION. Makhankov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1972. 31p. (CONF-720961–6). Dep. NTIS (U. S. Sales Only).

From Symposium on plasma heating and injection; Varenna, Italy (21 Sep 1972).

The enhanced heating of plasma by laser radiation is discussed. The systematization of thresholds of instabilities is given, and contributions of various instabilities into the anomalous dissipation are compared. Dense plasma, in which Coulomb collisions are essential, is especially considered. (auth)

13660 (MATT–928) HEATING A TOKAMAK PLASMA. Stix, T. H. (Princeton Univ., N. J. Plasma Phyics Lab.). Oct 1972. Contract AT(11-1)-3073. 22p. (CONF-720961–4). Dep. NTIS.

From Symposium on plasma heating and injection; Varenna, Italy (21 Sep 1972).

An attempt is made to assess the role of heating in the context of the entire problem of the attainment of controlled fusion. Attention is directed to toroidal configurations (primarily tokamaks). The dominant processes for the transport of heat from the plasma across the magnetic field to the wall are examined, namely: thermal conduction, bremsstrahlung, and synchrotron radiation. Balancing this heat loss is the input from Ohmic heating, alpha particles, and from supplementary sources. A zero-dimensional neoclassical model is used to find asymptotic conditions. This simple model enables one to make a quick survey over a wide range of device parameters and to evaluate the need for and the effectiveness of given amounts of supplementary heating power. It is found that really modest amounts of added heat can introduce impressive changes in laboratory plasmas and can greatly simplify the ignition of a reactor plasma. (auth)

13661 (MATT–929) PHYSICS OF RF HEATING. Stix, T. H. (Princeton Univ., N. J. Plasma Physics Lab.). Oct 1972. Contract AT(11-1)-3073. 19p. (CONF-720961–5). Dep. NTIS.

From Symposium on plasma heating and injection; Varenna, Italy (21 Sep 1972).

Electrical power passes through six identifiable stages in radio-frequency plasma heating. The first three are (1) rf generation, (2) transmission of rf power to the plasma surface, and (3) coupling of rf energy to the plasma. An efficient form for Stage (3) is to match the frequency and parallel wavelength of the driving field to those of a natural mode in the plasma, thereby exciting a "coupling resonance." Stage (4) is the modification of the rf wave or perturbation in the plasma, which may take place due to either linear or nonlinear processes. Stage (5) is the absorption of the wave in the plasma, which must compete with eddy current dissipation in the walls, and Stage (6) is the effective thermalization of the energy added to the plasma. These stages are discussed in turn. (auth)

13662 (MATT–938) SURVEY OF EXPERIMENTS ON PARAMETRIC INSTABILITIES AND ANOMALOUS ABSORPTION. Porkolab, Miklos (Princeton Univ., N. J. Plasma Physics Lab.). Nov 1972. Contract AT(11-1)-3073. 19p. (CONF-720961–2). Dep. NTIS.

From Symposium on plasma heating and injection; Varenna, Italy (21 Sep 1972).

In rf heating experiments the possibility of parametric instabilities must be recognized. The experimental evidence for the occurrence of parametric instabilities and associated anomalous absorption and/or heating will be surveyed. The experiments performed in the past few years can be divided according to geometry as follows: (1) excitation by grids (including probes and capacitor plates); (2) cavity excitation; and (3) microwave irradiation from waveguides. The advantages and disadvantages of these techniques are compared by discussing specific laboratory experiments. The evidence of anomalous absorption and heating, as being due to parametric instabilities, is discussed. (auth)

13663 (TRITA-EPP–72-21) IMPERMEABLE PLASMAS CONFINED IN POLOIDAL MAGNETIC FIELDS. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Sep 1972. 106p. Dep. NTIS (U. S. Sales Only).

Theoretical and experimental research on plasma confinement and stability being performed along the following main lines is reviewed: (i) The plasma density n is chosen in the impermeable range, i.e., well above the limit $n_c \sim 10^{20}$ cm^{-3}. In this range a hot plasma of laboratory dimensions can be shielded from a surrounding neutral gas blanket by a narrow partially ionized boundary layer. (ii) Plasma confinement is provided by a purely poloidal magnetic field, generated by an internal conductor system. The latter is suspended by magnetically shielded supports in a way to produce a closed magnetic bottle. (iii) Plasma generation and preheating is provided by the rotating plasma technique. The latter also leads to an improvement of magnetic mirror confinement in open bottles. (iv) Plasma stabilization is provided by the action of limiters producing magnetic line-tying at the edge of the narrow, cool, and dense partially ionized plasma boundary layer, and by finite Larmor radius and viscous effects. These lines, which differ in several respects from those of more conventional research programmes, are considered both in connection with fusion research on a laboratory scale and with the development of a full-scale fusion reactor. (auth)

13664 PLASMA CONFINEMENT IN A COMBINED MIRROR–MULTIPOLE MAGNETIC FIELD. Yatsu, K.; Morimoto, S. (Tokyo Univ. of Education). J. Phys. Soc. Jap.; 34: No. 1, 196-200(Jan 1973).

The behavior of plasmas confined in a combined mirror–multipole magnetic field is studied experimentally. The magnetic field is formed by the combination of a mirror field and an octupole field produced by using internal conductors. Plasmas, produced either by microwave heating or by a rail gun, are stably confined with the confinement time of about 0.9 ms. Measurements of particle loss show that half of the plasma is lost in the radial direction and another half is lost to the ends. Fluctuations are observed near the boundary of the plasma but they do not appear to be an important source of the plasma loss. (auth)

13665 REDUCTION BY MAGNETIC FOCUSING OF MULTIPLE COULOMB SCATTERING LOSSES IN DEVICES CONTAINING FULLY IONIZED MATTER. Miller, R. A. (Rutgers–The State Univ., New Brunswick, NJ). Phys. Rev. Lett.; 29: No. 24, 1590-2(11 Dec 1972).

Expressions are developed for multiple Coulomb scattering losses in magnetic focusing devices containing fully ionized matter in the form of "self-colliding orbits." These relations are directly applicable to "migmacell" and Precetron orbits and are generally applicable to other magnetic confinement devices. Fo-

cusing forces have a significant effect over a single-particle orbit. For the case of a "migmacell" as it is visualized, confinement times of the order of 1000 sec are predicted in the absence of other losses. (auth)

13666 HEATING OF PLASMA IONS NEAR LOW HYBRID FREQUENCIES. Tarasenko, V. F.; Shvets, O. M. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 133-5(Jan 1972). (In Russian).

The results of heating plasma ions by a fast, magnetosonic wave near lower hybrid resonance are reported. The dependence of resonance peaks on the intensity of the external magnetic field at various plasma densities was in agreement with theory. The transverse ion energy exceeded the longitudinal energy by a factor of five. (tr-auth)

13667 TURBULENT HEATING OF DENSE ISOTHERMAL PLASMA WITH A TRANSVERSE CURRENT. Pyatak, A. I.; Sizonenko, V. L. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 146-9(Jan 1972). (In Russian).

Excitation and development of longitudinal waves in a dense ($n_0 \gg H_0^2/4\pi m_e c^2$) isothermal plasma current that flowed perpendicular to an external field H_0 were investigated. The incremental growth and frequency of oscillations were found. The energy of the oscillations in a turbulent regime was evaluated for the moment when the increase in oscillations was checked by the nonlinear interaction of a wave. Plasma heating by electron and ion scattering in turbulent pulsations of the electric field of unstable oscillations was investigated. (tr-auth)

13668 INFLUENCE OF THE TIME MODULATION OF THE TOROIDAL ELECTRIC FIELD ON THE TRANSPORT PROPERTIES OF A TOKAMAK PLASMA. Nocentini, A. (Univ., Trieste, Italy). Lett. Nuovo Cim.; 5: No. 12, 824-8(18 Nov 1972).

The usual tokamak plasma is considered, for which the following ordering is appropriate: $(\nu/\Omega) \sim (R_L/R) \sim O(\epsilon)$, $(e\Phi/T) \sim \beta \sim (\omega_p/\Omega) \sim O(1)$, $(cE_T/v_{th}B) \sim O(\epsilon^2)$, where ϵ is a small parameter (so small that the square root of the mass ratio can be chosen of order 1, and the two species can be treated on the same foot), ν, Ω, and ω_p are the collision, cyclotron, and plasma frequencies, R_L is the Larmor radius, R the radius of the torus, Φ is the electric self-potential, T the temperature, β is the ratio of the kinetic to the magnetic pressure, v_{th} and c the thermal and light speeds, E_T the dc external electric field that drives the toroidal current, and B is the magnetic field, with poloidal and toroidal components B_ν and B_T, of the same order. An oscillating, toroidal electric field, E_T^{os}, with frequency ω of the same order of the collision frequency ν, and then also of the bounce frequency ω_b is applied to the plasma. Due to the smallness of parameter ϵ, any subordering among these frequencies is possible. The order of magnitude of E_T^{os} is then determined a posteriori, by the requirement that the averaged in time diffusion due to E_T^{os} be comparable to the neoclassical diffusion. The appropriate ordering is $(cE_T^{os}/v_{th}B) \sim (\omega/\Omega) \sim O(\epsilon)$. It is shown that with this ordering, the heating due to E^{os} is of the same order of the Ohmic heating provided by the discharge. (MOW)

13669 ANOMALOUS HEATING OF A PLASMA BY A HALL CURRENT. Aref'ev, V. I.; Khmelinin, B. A. High Temp. (USSR) (Engl. Transl.); 10: No. 2, 193-195(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 217-220 (1972).

The mechanism of anomalous plasma heating in accelerators with crossed E, H fields as a consequence of ion-acoustic instability of the Hall current is considered. The limiting estimates for the ion and electron temperatures and the Mach number are obtained. (auth)

Diagnostics

Refer also to abstracts 12632 and 13775.

13670 (AD-745964) EXPERIMENTS ON THE APPLICATION OF LASER SELECTIVE EXCITATION SPECTROSCOPY TO THE DIAGNOSTICS OF A POTASSIUM PLASMA. Rodrigo, A. B. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Apr 1972. 130p. (UTIAS-180; AFOSR-TR-72-1193). NTIS.

A thermally tuned Q-switched ruby laser of moderate power, with emission wavelength at 6939A, was used to selectively excite the $4\ ^2P_{\frac{1}{2}} - 6\ ^2S_{\frac{1}{2}}$ transition in the atoms of a pure potassium plasma of low degree of ionization produced in a hot cathode diode. A pulse of intensified spontaneous emission has been produced at 6939A, 6911A, and at a number of other wavelengths as a result of the laser selective excitation. The characteristics of the plasma intensified emissio[illegible]lse were observed to depend on the local conditions of the plasma, at the point of intersection of the laser beam and the solid angle of observation, estimated by a Langmuir probe. The possibility of using this type of interaction for the purpose of diagnosing the plasma was studied experimentally. (auth)

13671 (AD-746094) THEORY OF ION BOUNDARY LAYERS. Johnson, R. A.; de Boer, P. C. T. (Cornell Univ., Ithaca, N. Y. Graduate School of Aerospace Engineering). 24 Jan 1972. Contract N00014-67-A-0077-0001. 7p. NTIS.

Revision of report dated 26 Aug 1971.

Theories are presented for the electric boundary layers that form on flat-plate and cylindrical probes aligned parallel with a high-speed flow, when the probe potential is large and negative. Both slightly ionized continuum flows and collisionless plasmas are considered. In the former case, the probe potential is supposed sufficiently large to make the electric boundary layer thick compared with the viscous boundary layer. The corrections arising from the presence of the viscous boundary layer are calculated. The cases considered are solved either by an integral method, or by a quasi-one-dimensional method. The results obtained can be used to determine the free-stream ion density from the current measured experimentally. A comparison is made between theory and some available experimental data. (auth)

13672 (AWRE-O-56/72) TIME OF FLIGHT/ENERGY ANALYSIS OF ARC PLASMA. Powell, H. P. S.; Owen, W. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct 1972. 20p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The application of a combined time of flight/electrostatic energy analyzer is used to investigate the properties of the multicomponent plasma produced by an arc ion source. The method allows, in principle, for determination of the energy/velocity distributions of the individual plasma components. (auth)

13673 (INR-P-1414) MEASUREMENTS OF ENERGY DISTRIBUTION OF PLASMA IONS WITH AN ELECTROSTATIC ANALYZER. Sadowski, M.; Skladnik-Sadowska, E.; Sudlitz, K. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 34p. Dep. NTIS (U. S. Sales Only).

Measurements of ion energies and impurity concentrations provide direct knowledge of plasma composition and its thermodynamic state. An electrostatic energy analyzer with cylindrical deflector plates is described, and results of measurements performed with that instrument are presented. The detailed description of the operation and a theoretical analysis of the operational conditions of such an analyzer are given. An experimental setup for calibration measurements is described, and main results of such measurements are presented. Some results of preliminary research on energy distribution of plasma ions generated by a coaxial injector are also given. (auth)

13674 (TRITA-EPP-72-20) AN ION FLUX PROBE FOR A LOW PRESSURE DISCHARGE PLASMA. Torven, S.; Babic, M. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Sep 1972. 11p. Dep. NTIS (U. S. Sales Only).

Fine apertures drilled in a thin metal plate inserted in the confining glass wall connect the discharge column with an external volume containing a pressure gage. Atom and ion fluxes are derived from pressure measurements made at different electric potentials of the metal plate. The results are compared with measurements by Langmuir-probe characteristics. (auth)

13675 OPTICAL DETERMINATION OF THE ION AND ELECTRON TEMPERATURES IN A BARIUM Q PLASMA. Gekelman, W. N. Hoboken, NJ; Stevens Inst. of Tech. (1972). 201p. University Microfilms Order No. 72-31,162.

Thesis.

The ion and electron temperatures were optically determined in a single-ended barium Q machine. Circumstances under which the Corona model may be used in the electron temperature determination are discussed. The ion temperature was deduced by measuring the Doppler broadening of a visible barium emission line. A discussion of the optical systems used is included. When there is no current drawn along the plasma column the electron and ion temperatures are equal to the hot plate temperature within the experimental accuracy. When an electron current is drawn, both species temperatures increase, the ion temperature always being larger. The species temperatures saturate with $T_e \sim .5eV$; $T_i \sim 5eV$. Oscillations, which become turbulent noise when a threshold voltage is applied along the column, are observed. Above this threshold, current drawn is not proportional to applied voltage. Anomalous resistivity is discussed as a likely heating mechanism. (Diss. Abstr. Int., B)

13676 INPUT RESISTANCE OF A SHORT DIPOLE ANTENNA IN A WARM UNIAXIAL PLASMA. Baenziger, G.; Kuehl, H. H. (Univ. of Southern California, Los Angeles). Radio Sci.; 7: No. 12, 1117-29(Dec 1972).

The input resistance of a short dipole antenna immersed in a warm magnetoplasma is calculated on the basis of the kinetic theory (Boltzmann equation). The plasma is uniaxial; i.e., the cyclotron frequency is much larger than the operating frequency of the antenna and the plasma frequency. The plasma is homogeneous, and collisions are included although the sheath is neglected. The dipole is assumed to be infinitesimally thin (producing an infinite input reactance) except for the case in which the dipole axis is parallel to the static magnetic field when the dipole is allowed to have a nonzero radius and calculate the input impedance. It is found that at frequencies much less than the plasma frequency the input resistance differs markedly from the hydrodynamic and cold-plasma results because of collisionless absorption processes. The input resistance is generally smaller when the dipole axis is inside the resonance cone than when it is outside. The resonance cone anomaly in the input resistance is reduced in magnitude from that of the cold-plasma theory and is shifted to a higher frequency. (auth)

13677 INTEGRAL EQUATION AND BOUNDARY CONDITIONS FOR A CYLINDRICAL ANTENNA IN A WARM PLASMA. Preis, D. H. (Harvard Univ., Cambridge, MA). Radio Sci.; 7: No. 12, 1143-9(Dec 1972).

The linearized, continuum fluid-dynamical equations for a warm, collisional electron plasma with independent source terms are presented, and their applicability to boundary-value problems is discussed. Boundary conditions are developed for a perfectly conducting cylindrical antenna immersed in the warm collisional plasma and excited by a delta-function generator. An integral equation relating the antenna surface current and charge is derived based upon all the conventional boundary conditions and the requirement that proper continuity be maintained between the antenna and the plasma. The deficiency of other integral formulations, including the grid-type dipole, is discussed. (auth)

13678 PLASMA DENSITY MEASUREMENT USING A LANGMUIR PROBE IN THE PRESENCE OF A MAGNETIC FIELD. Ripault-Misguich, J. (CEN, Fontenay-aux-Roses, France). J. Phys. (Paris); 33: No. 8, 761-9(Aug 1972). (In French).

A method for measuring the density of a fully ionized magnetized plasma is deduced from the theoretical study of electron collection by a plane Langmuir probe parallel to the magnetic field. The probe is much smaller than the mean free path, but it is of the same order of magnitude as the ion gyroradius, and is much larger than the electron gyroradius (which is itself larger than the Debye length). The ion current, which is proportional to the probe area is much smaller than the electron current when the probe bias is positive. The electron current, which is proportional to the probe cross section and to the electron gyroradius, is almost independent of the ion temperature. (France)

13679 EVALUATION OF AN ORIFICE PROBE FOR PLASMA DIAGNOSTICS. Prokopenko, S. M. L.; Laframboise, J. G.; Goodings, J. M. (York Univ., Toronto). J. Phys., D (London); 5: No. 12, 2152-60(Dec 1972).

An orifice probe is described which permits determination of bulk plasma parameters, including temperatures, number densities and space potential, and which also permits simultaneous use of a mass spectrometer sampling through the same orifice. This probe combines a small, sharp-edged orifice located in a conducting wall with a planar internal geometry which is amenable to calculation. A detailed current-collection theory for a collisionless plasma is described. Experimental orifice probe characteristics are analyzed for low-pressure ($<10^{-2}$ torr) rf plasmas in argon operating at 90 MHz with power levels of less than 60 W. The effects of secondary electron emission, electron reflection, field penetration, plasma inhomogeneities, and collisions in the sheath are examined. The electron and ion saturation regions ($i_{sat} = 10^{-8}$ to 10^{-9} A) and the electron-retarding region of the characteristics are found to indicate the properties of the bulk plasma. Values are obtained for the electron temperature kTe (<5 eV) and number density n_e (10^8 to 10^{10} cm^{-3}), together with an independent estimate of ion number density $n_i = O(n_e)$. Space potential (15 to 25 V) can be determined within 0.5 V. An upper bound for kT_i can be found, together with an indication of the degree of homogeneity of the plasma being sampled. (auth)

13680 ADMITTANCE PROBE MEASUREMENTS IN THE DOUBLE INVERSE PINCH DEVICE. Baum, P. J.; Pollack, J. (Univ. of California, Riverside). J. Appl. Phys.; 44: No. 1, 163-7(Jan 1973).

A floating voltage swept double probe is described and the components of the plasma sheath admittance ($Y = 1/R + j\omega C$) are measured as a function of time in argon and hydrogen. The measurements are carried out in the double inverse pinch device (DIPD Mark I), a pulsed device, which generates a quadrupole magnetic field. The probe is swept at 500 kHz with a sinusoidal voltage. Sheath capacitance and resistance are measured at one point in space and at a variety of times following preionization. The plasma sheath parameters are discussed in terms of equivalent circuits which are found to simulate the plasma sheath response. The sheath capacitance is larger than predicted by present theories. Estimates of plasma temperature and density are made from the sheath measurements and are found to be low owing to the theoretical uncertainty in capacitance. With improvement in sheath theory, the technique should give accurate temperature and density measurements in transient plasmas. (auth)

13681 IONIZATION MEASUREMENTS BEHIND SHOCKS IN ARGON WITH MICROWAVES AND A PULSED LANGMUIR PROBE. Schneider, K. P.; Groenig, H. (Technische Hochschule, Aachen). Z. Naturforsch.; 27a: No. 12, 1717-30(Dec 1972). (In German).

The ionization of shock-heated argon was measured by means of the attenuation and phase shift of transmitted microwaves of 2.5 and 8 mm at shock Mach numbers $7.5 \leq M_s \leq 11.8$ and initial pressures $3 \leqq p_1/\text{torr} \leqq 20$. Taking into account the boundary layer at the shock tube wall it is possible to evaluate the plasma density and electron collision frequency from specially prepared attenuation-phase angle-diagrams. A pulsed Langmuir probe was tested regarding its feasibility to measure the plasma density and the electron temperature. The reaction rate equations of Jahn and Harwell including the ionization of impurities were solved in order to interpret the plasma density profiles. The theoretically required reaction rates for the ionization of argon by an excitation process, k^* and k_1^+, and for ionization by collisions between electrons and argon atoms, k_3^+, were experimentally determined. (auth)

13682 PLASMA DIAGNOSTICS BY MEANS OF OBLIQUE PROBING OF A PLANE WAVE. Kartashev, V. G.; Mayorov, A. P. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 4, 695-7(Apr 1972).

Translated from Radiotekh. Elektron.; 17: No. 4, 885-6(1972).

Existing methods of inhomogeneous plasma diagnostics are based on a geometrical optics approximation and are only applicable for a small variation of plasma density within a wavelength. A theoretical analysis is presented of new diagnostics methods for an inhomogeneous planar-stratified collision-free plasma that is valid for a large variation in plasma density within a wavelength. The method is based on the oblique irradiation of a planar-stratified plasma by a plane wave; the wave is incident from a homogeneous dielectric onto a plasma layer, the density in which is to be measured in the z direction; the wave polarization is perpendicular to the plane of incidence. (auth)

13683 RESOLUTION OF THE AMBIGUITY OF MEASUREMENT BETWEEN ROTATION AND ELLIPTICITY IN THE MICROWAVE POLARIMETRY OF NONSTATIONARY PLASMAS. Sardos, R. (Univ. Bordeaux, Talence, France). Rev. Sci. Instrum.; 43: No. 11, 1726-7(Nov 1972).

Given the growing importance of careful and precise measurements with microwaves in the study and analysis of plasmas (Faraday effect, Cotton–Mouton–Voight effect, etc.) the author proposes the use of an interference polarimeter–ellipsometer of great sensitivity capable of recording at the same time both rotation and ellipticity. This instrument may also be used as a reflector-polarimeter (in the study of Kerr effects). (auth)

Kinetics (General)

Refer also to abstract 12963.

13684 (AD-745736) SOFT X-RAY EMISSION FROM DOUBLE-ELECTRON RADIATIVE TRANSITIONS IN PLASMA IONS. Elton, R. C.; Palumbo, L. J. (Naval Research Lab., Washington, D. C.). 29 Mar 1972. 18p. (NRL-MR-2457). NTIS.

A broad emission blend is observed near 17 A from a plasma produced in a theta-pinch deuterium discharge seeded with neon. The feature is associated with $KL^m \rightarrow L^{m+2}$ + light where $M \geq 6$ double-electron radiative transitions resulting from the filling of a K-shell vacancy in the higher ionization species of the neon atoms by an L-shell electron, the simultaneous ionization (shake-off) or excitation (shake-up) of a second L-shell electron, and the emission of a photon. The observed spectral distribution of the blend is compared with the spectral distributions computed for various ion species by convoluting the instrument profile of the spectrograph with the predicted wavelengths and relative intensities of the shake-up lines and shake-off continua. A percentage probability for radiative- Auger shake-off in agreement with theory

is derived from the Ne VIII portion of the measured spectrum. The possibilities of such transitions for enhanced plasma cooling and for gain by stimulated emission are mentioned. (auth)

13685 (AD–745955) NEUTRON ENERGY AND FLUX DISTRIBUTIONS FROM A CROSSED-FIELD ACCELERATION MODEL OF PLASMA FOCUS AND Z-PINCH DISCHARGES. Report for September 1969–September 1971. Bernstein, M. J.; Comisar, G. G. (Aerospace Corp., El Segundo, Calif.). May 1972. Contract F04701-71-C-0172. 40p. (SAMSO-TR-72-165). NTIS.

Anisotropic distributions of neutron fluxes and neutron energy spectra are calculated for D–D reactions in self-pinching discharges, particularly for a plasma focus. A generalized beam–target model is assumed where (1) high-energy deuterons have angular distributions consistent with a crossed-field acceleration mechanism, and (2) these energetic deuterons undergo fusion collisions primarily with stationary target ions. Energy distributions of ions proportional to $1/E_d^3$ in the range from 50 to as high as 600 keV give computed results agreeing with many experimental observations at laboratory angles of 0, 90, and 180°. These ion-energy distributions can account for a 50- to 100-fold increase in neutron yield when a deuterium–tritium gas mixture is used. (auth)

13686 (AD–746044) MAGNETIC FIELD ANNIHILATION OF IMPULSIVE CURRENT SHEETS. Interim Scientific Progress Report. Dailey, C. L. (TRW Systems Group, Redondo Beach, Calif.). 31 May 1972. Contract F44620-71-C-0031. 37p. (AFOSR-TR-72-1307). NTIS.

The report presents the results achieved to date from an experimental study of impulsive plasma acceleration in an inductive device. The geometry of the magnetic fields produced in this machine is such that plasma acceleration by means of a hydromagnetic wave, that converts field energy to kinetic energy, is expected to occur. The purpose of the experiment is to study this mechanism of plasma acceleration by magnetic field annihilation. The experimental data consist of measurements of the radial and axial magnetic field components as a function of time and location within the accelerator. A computer analysis of these data was made and the results are presented as magnetic flux contour maps and contour maps of plasma current density which are calculated by the computer from the magnetic field data. The maps are also drawn by the computer. (auth)

13687 (AD–746098) LASER-INDUCED SOURCES FOR MAGNETIC FIELDS. Stamper, J. A. (Naval Research Lab., Washington, D. C.). 16 Jun 1972. 24p. (NRL–7411). NTIS.

Large magnetic fields are produced near the target when a powerful laser pulse is focused onto a solid target. A discussion is given of how the laser radiation produces conditions in the laser-produced plasma which allow the conversion of thermal energy to magnetic field energy. This concept of a thermal source generating the magnetic field is illustrated by deriving the source function for a spherical plasma. It is shown that the necessary nonadiabatic conditions exist in the presence of laser radiation. At a sufficiently high intensity ($\sim 10^{14}$ W/cm^2), the linear polarization of the radiation produces a corresponding anisotropy in the electron velocity distribution. Magnetic sources then exist for any spatial variation of pressure and density. Sources due to the direct action of radiation pressure are also discussed. This implies that part of the laser radiation is absorbed by direct conversion (no heating) from laser field energy to magnetic field energy. An estimate is made of the magnetic field produced in the region where laser radiation is being absorbed. Such fields can be quite large—in the megagauss range. (auth)

13688 (AD–747057) TAPERED COAXIAL PLASMA GUN ELECTRODES. Report for January 1–June 30, 1971. Clark, J. G. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jun 1972. 36p. (AFWL-TR-72-39). NTIS.

The effect of using tapered electrodes with a coaxial plasma gun is studied numerically with a computer. For low-impedance capacitor banks, a 30% or larger increase in linear current density before the collapse into a pinch is predicted. The neutron yield should be proportional to the fourth power of the linear current density before collapse. Thus, a factor of three or more in neutron production is predicted without increasing the stored energy of a given capacitor bank. (auth)

13689 (GULF-GA-A-12374) IMPURITY RADIATION LOSS ESTIMATION FROM FUSION REACTOR PLASMAS. Hopkins, G. R. (Gulf General Atomic Co., San Diego, Calif.). 30 Oct 1972. Contract AT(04-3)-167. 12p. (CONF-721111–19). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

Radiation losses by impurities from a high-temperature plasma may be considered due to three major processes: bremsstrahlung, line or excitation radiation, and recombination. The relative importance of these three radiation loss processes depends on the plasma temperature and the atomic number of the impurity. Calculations of these losses are given for various parameters. (MOW)

13690 (LBL–1018) PROGRESS IN THE DEVELOPMENT OF HIGH-INTENSITY NEUTRAL BEAMS. Kunkel, W. B. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1 Sep 1972. Contract W-7405-eng-48. 25p. (CONF-720961–1). Dep. NTIS.

From Symposium on plasma heating and injection, Varenna, Italy (21 Sep 1972).

The extractor and the plasma source are described in some detail. The design, beam diagnostics, performance, and energy modulation are discussed for the extractor system. The design and some results are described for the plasma source. (M.O.W.)

13691 (UPee–71/4) CHARACTERISTIC OF A DIFFUSION PLASMA. Malesani, L.; Moresco, M.; Zilli, E. (Padua Univ. (Italy). Istituto di Elettrotechnica e di Elettronica). 1971. 10p. INIS.

Improvements to an experimental device for the production of a diffusion plasma were carried out in order to get more favorable performance, particularly concerning noise and stability. Results of measurements performed to point out the effectiveness of the adopted provisions on the plasma characteristics are reported. (INIS)

13692 INVESTIGATIONS OF SELF-MAGNETIC PLASMA ACCELERATORS. Huegel, Helmut (Institut fuer Plasmadynamik, Stuttgart). Raumfahrtforschung; 16: No. 5, 232-9(1972). (In German).

A coaxial plasma accelerator (arc-jet engine) without an external magnetic field is operated stationarily at discharge currents of 1000 to 6000 A using argon as working fluid. Integral performance data of the device are presented. The method of deducing therefrom values of the mean mass velocity and efficiency is discussed with concern for the possibility of entrainment. The flow field is investigated by the aid of aerodynamic yaw and Pitot probes. Experimental investigations and a theoretical analysis indicate that the mass flow rate should not fall below a lower limit in order to establish a stationary discharge mode at a constant arc-current. (auth)

13693 PARAMETRIC ACCELERATION OF IONS IN A VARIABLE MAGNETIC FIELD. Pasechnik, L. L.; Prokhorov, M. M.; Yagola, V. V. (Inst. of Nuclear Research, Kiev). Dokl. Akad. Nauk SSSR; 204: No. 5, 1084-5(11 Jun 1972). (In Russian).

The motion of He ions in He was studied in a direction perpendicular to a magnetic field and in the presence of a changing electric field. The experimental lamp was a quartz cylinder 70 × 4 cm placed in a homogeneous magnetic field. Along the axis of the cylinder passed a 300-eV electron beam modulated at low frequency. The ions formed diffused to the cylinder wall and were collected. (K.S.W.)

13694 CONFINED-DISCHARGE PLASMA GENERATOR WITH LOCAL FLUID CONSTRICTION. Mahan, J. R. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Cremers, C. J. J. Basic. Eng.; 94: No. 4, 818-24(Dec 1972).

Normally the energy conversion efficiency of a confined-discharge plasma generator is inversely related to the mean enthalpy of the effluent plasma jet. This paper describes a technique for increasing both the energy-conversion efficiency, defined as the net fraction of the electrical power input transferred to the working fluid, and the mean enthalpy, defined as the net energy transferred to the working fluid per unit mass. A portion of the working fluid is introduced to the discharge through a narrow circumferential slit in the confining duct wall. Heat-transfer and fluid-dynamic effects associated with this high-velocity inflow of cold gas cause the local discharge column to become highly constricted. Concomitant with this local fluid constriction (LFC) is a sharp increase in the local power density, resulting in enhanced energy transfer to the cold gas. Experimental results suggest that for optimum operation the gas injection slit should be located slightly upstream of the axial position where the discharge becomes thermally fully developed. (auth)

13695 INVESTIGATION OF THE GUN ASPECTS OF A ROTATING PLASMA SOURCE. Harder, C. R.; Forsen, H. K. Univ. of Wisconsin, Madison). J. Appl. Phys.; 44: No. 1, 82-90(Jan 1973).

A crossed field or rotating plasma gun is investigated to determine detailed processes taking place during the ionization and acceleration phases. Measurements suggest that the gun breaks

down via a spoke which subsequently rotates at the limiting velocity. Internal shorting occurs subsequent to break down and limits the usefulness of the source. Methods of reducing the effects of this shorting are presented as are some measurements of the properties of the plasma after it leaves the gun region. These suggest that about 10^{19} particles can be accelerated to energies of several hundred eV. (auth)

13696 INFLUENCE OF TIME ORDERING ON UNIFIED LINE PROFILES. Voslamber, D. (CEN, Fontenay-aux-Roses, France). Z. Naturforsch.; 27a: No. 12, 1783-92(Dec 1972).

The "width and shift" operator occurring in a previously developed unified theory of Stark broadening by plasma electrons is approximated by different expressions which include time ordering to various orders (up to order four). For the special case of the Lyman-α line in the dipole approximation results also including time ordering to all orders are calculated and compared to the approximate results. Numerical evaluations for this case are presented using the wing expression of the unified theory. A particularly good agreement with the exact profile is obtained for an approximation which maintains time ordering to fourth order. As for the accuracy of un-time-ordered profiles, the results are less optimistic than those of Godfrey et al. The role of an accurate thermal average concerning the effect of time ordering is emphasized. (auth)

13697 LARGE DOUBLE PLASMA DEVICE FOR PLASMA BEAM AND WAVE STUDIES. Taylor, R. J.; MacKenzie, K. R.; Ikezi, H. (Univ. of California, Los Angeles). Rev. Sci. Instrum.; 43: No. 11, 1675-8(Nov 1972).

The DP (or double plasma) device consists of two essentially collisionless plasmas that are separated from each other (for electrons only) by a negatively biased grid. Large cross section beams of ions are produced in one plasma by raising the potential of the other. Ion waves or shocks are produced in one plasma by oscillatory or large sudden (or ramp) potential changes in the other. Electrons emitted from two electrically separate spatial arrays of small filaments produce the two plasmas with densities in the range from below 10^8 to $\sim 10^{10}$ ion/cm^3 with noise levels $\langle \delta n/n \rangle \approx 5 \times 10^{-4}$. (auth)

13698 STUDY OF THE ELECTRICAL AND LIGHT PHENOMENA IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. Grosu, Csenia (Univ., Iasi). Stud. Cercet. Fiz.; 24: No. 9, 1099-1121(1972). (In Rumanian).

The following sections are presented: (1) glow discharge characteristics, (2) experimental procedure and arrangement, (3) experimental results; proper oscillation frequency of the positive column, (4) step variations of the applied voltage on the tube electrodes, of the frequency and the form of the electrical oscillations taken from the anode, (5) electrical and light phenomena along the positive column, and (6) discussion and explanation of the experimental data. (auth)

13699 RELAXATION IN A TWO-TEMPERATURE PLASMA WITH DIRECTED ELECTRON MOTION. Akhiezer, I. A.; Angeleiko, V. V. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz.; 63: No. 6, 2139-43(Dec 1972). (In Russian).

Temperature and energy relaxation of the directed motion of particles in a two-temperature plasma with directed electron motion is investigated in the presence and absence of an external magnetic field. It is shown that the rate of variation of the particle energy in such a plasma may strongly differ from that for the particle energy in a plasma without directed electron motion. (auth)

Kinetics (Experimental)

13700 (AD-747339) UV RADIATION MEASUREMENTS. Reilly, D. A.; Patrick, R. M. (Avco-Everett Research Lab., Everett, Mass.). May 1972. Contract DASA01-71-C-0112. 57p. (DNA-2928-F). NTIS.

Collisional momentum transfer cross sections and their relation to the Avco momentum coupling experiment are discussed. Cross sections that account for electron shell interpenetration predict total mass pickup on a collisional basis, but the short-scale lengths for density jumps are not fully explained. The previously reported effect of a magnetic field on the coupling was found to be due to the field's influence on the initial spreading of the streaming Al plasma, which changed the amount of intercepted background air. Measurements of the plasma ultraviolet radiation have established this mechanism as a major source of energy loss. Energy balance calculations are in agreement with the measured electron temperature. Increases in initial plasma velocity and decreases in initial mass and background density have moved the experimental parameters to the borderline of the collisional regime. Directions for further improvement are discussed. (auth)

13701 MEASUREMENT OF THE dc PLASMA ELECTRIC RESISTIVITY PERPENDICULAR TO THE MAGNETIC SURFACE. Okabayashi, M.; Yoshikawa, S. (Princeton Univ., NJ). Phys. Rev. Lett.; 29: No. 26, 1725-8(25 Dec 1972).

The measurement of the dc electric plasma resistivity perpendicular to the magnetic surface in a toroidal device was carried out using the FM-1 spherator. It was found that the perpendicular resistivity is inversely proportional to the neutral gas density and is independent of plasma density for a He^+ plasma at $T_e = 1$ eV. These parametric dependences are consistent with the resistivity expected from classical collisional processes. (auth)

13702 OBSERVATION OF SLOWING-DOWN OF ION-BEAM VELOCITY AND HEATING OF IONS. Fujita, T.; Ohnuma, T.; Adachi, S. (Tohoku Univ., Sendai). Phys. Lett.; 42A: No. 4, 319-20(18 Dec 1972).

In the measurements of spatial evolutions of ion beams in an ion beam–plasma system, the slowing-down of the ion-beam velocity and the thermalization of the ion beams were observed. (auth)

13703 RELAXATION OF ION BEAM INJECTED INTO A PLASMA TRANSVERSELY TO A MAGNETIC FIELD. Borisenko, A. G.; Kirichenko, G. S. (Inst. of Nuclear Research, Kiev). JETP Lett. (USSR) (Engl. Transl.); 16: No. 6, 247-9(20 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 6, 349-52(20 Sep 1972).

The argon plasma was maintained with a discharge in an external magnetic field. A potassium ion beam was injected into the plasma transversely to the magnetic field. The experiments show that superposition of even a relatively weak transverse magnetic field on the beam–plasma system leads to an effective relaxation of the beam. Distribution functions of the beam are given as functions of the magnetic field intensity. The author argues that the two-stream instability is an effective collisionless mechanism for the thermalization of an ion beam in a plasma. (MOW)

13704 INFLUENCE OF TRAPPING OF PARTICLES ON BEAM–PLASMA INTERACTIONS. Krlin, L. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 22: No. 12, 1240-1258 (1972).

In models of particles in two waves and in a spectrum (with given amplitudes), trapped particles are discussed for the region of harmonic oscillations. The range of resonances, the transport of energy, and a possibility of transition of the trapped beam into the quasiergodic state are described. For the case of a discrete spectrum, conditions for the beam diffusion are given and, within the framework of a system with mixing, conditions for existence of hf field–beam particles balance are discussed. (auth)

13705 MECHANISM OF MOTION OF INHOMOGENEITIES IN A NONEQUILIBRIUM PLASMA IN A MAGNETIC FIELD. Evdokimo, B. M.; Malikov, M. M. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 2, 201-205(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 227-231 (1972).

Results are presented of measurements of the velocity with which the inhomogeneities move in a nonequilibrium plasma having a developed ionizational turbulence. It is shown that inhomogeneities situated along the central current move due to the action of the ponderomotive force, while the gradient mechanism of motion does not introduce a substantial contribution. It is shown experimentally that for such motion the development of fluctuations of gas pressure is possible. (auth)

13706 COLLECTIVE PROCESSES IN THE PASSAGE OF HIGH-CURRENT RELATIVISTIC BEAMS THROUGH A GAS AND A PLASMA. Tkach, Yu. V.; Fainberg, Ya. B.; Magda, I. I.; (and others) (Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 259-61(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 368-71(5 Oct 1972).

The passage of a relativistic electron beam through a chamber 3 m long and filled with nitrogen at pressures of 10^{-2} to 20 mm Hg was investigated. When the beam passed through the gas, a plasma of density 10^{12} to 5×10^{13} cm^{-3} was produced, and the electron beam was compensated both in charge and in current. The return current in the plasma was 70 to 80% of the current in the beam. Various collective phenomena were studied for different experimental conditions. (MOW)

13707 SELF FOCUSING OF LIGHT IN A PLASMA AND SUPERSONIC IONIZATION WAVE IN A LASER BEAM. Batanov,

V. A.; Bunkin, F. V.; Prokhorov, A. M.; Fedorov, V. B. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 266-9(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 378-82(5 Oct 1972).

With developed evaporation of a bismuth target in a helium atmosphere of pressure P_0 = 2.5 to 5 atm by a laser beam (λ = 1.06 μ) of intensity $I_0 \approx 10^7$ W/cm^2 in a millisecond pulse, a plasma flare regime was obtained that is new for metals. The presence of strong absorption in the flare was demonstrated by passing through it a beam inclined 5° to its axis. It was found that at P_0 = 4 atm, a light energy E = 2.3 to 3.6 kJ in a pulse of τ = 0.8 msec, at a focusing-region dimension $d_0 \approx 0.8$ cm on the target, and a traversed flare length l = 4 to 6 cm, the beam was attenuated by a factor 5 to 10. This corresponds to an absorption coefficient averaged over time and length α = 0.4 to 0.6 cm^{-1}. A figure shows a time scan of the flare. (MOW)

Kinetics (Theoretical)

13708 (AD-744813) THEORETICAL CALCULATION OF X RADIATION FROM NONEQUILIBRIUM ALUMINUM PLASMAS. Boyd, R. W. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 89p. (GEP/PH-72-1). NTIS.

TORCH, a computer code which calculates the spectrum arising from the radiation of a metallic plasma, is described. The population of each ionic species is determined from a time-dependent corona model which includes three-body recombination. Both time-resolved and time-integrated spectra are obtained, showing the contributions from bremsstrahlung, recombination radiation, and line radiation. Ion and electron temperatures are allowed to differ, with radiative losses causing continuous electron cooling. Energy may be added to the electrons and/or ions at arbitrary rates, for arbitrary times, and TORCH will compute the temperatures based on the rates of radiation, ionization, and electron–ion energy exchange. Calculations are included for aluminum plasmas with electron densities of 10^{18} to 10^{21}/cm^3 and electron temperatures of 10 eV to several keV. Also included are calculations of radiation from a deuterium plasma with 5% aluminum impurities. (auth)

13709 (MATT-943) ANOMALOUS ABSORPTION OF RADIATION BY PLASMAS. Dawson, J. M. (Princeton Univ., N. J. Plasma Physics Lab.). Nov 1972. Contract AT(11-1)-3073. 36p. Dep. NTIS.

A discussion of results from theory and computer simulation of a number of topics relevant to the anomalous absorption of radiation by plasma is given. Among such topics are the following: (1) When intense laser radiation falls on a plasma whose plasma frequency is near the laser frequency, it can cause parametric instabilities in which ion density fluctuations and electron plasma waves grow to a saturation level determined by nonlinear processes such as wave scattering and particle trapping. The turbulence generated leads to a strong anomalous absorption. Such absorption deposits most of the energy in the electrons and often leads to highly energetic tails on the electron distribution function. A similar type of enhanced absorption can be produced by two laser beams whose beat frequency is near the plasma frequency. (2) Enhanced ion fluctuations can also lead to anomalous absorption of radiation when the transit time of a thermal electron across a typical ion fluctuation is of the order of the period of the electromagnetic wave. While the enhanced ion density fluctuations might be produced externally or by other instabilities, the processes giving rise to anomalous absorption tend to amplify them and thus to maintain their level. Enhanced absorption of this kind leads to a heating of the main body of the electrons and not to the energetic tails produced by resonant absorption. This form of enhanced absorption can be effective for laser frequencies up to ten times the plasma frequency. (3) Intense laser radiation can interact with enhanced ion fluctuations to produce dc electric currents. Such currents could generate intense magnetic fields that can influence the absorption process. (auth)

13710 DERIVATION OF THE SPECIAL NYQUIST THEOREM FOR THE RELATIVISTIC AND QUANTUM-MECHANICAL DOMAINS. Dirk, E. H. University Park, NM; New Mexico State Univ. (1972). 100p. University Microfilms Order No. 72-31,644.

Thesis.

The special Nyquist theorem (i.e., the four-dimensional form of the conventional theorem valid for space–time-dependent current fluctuations) is derived in a rigorous manner by considering the behavior of a single electron in a partially ionized gaseous plasma. A generalization of Chambers' kinetic theory is used and contrary to the usual procedure in plasma physics, collisions of the electrons are explicitly taken into account. The effects of an external electromagnetic perturbation are analyzed and the resultant nonlocal conduction equation leads to the special Nyquist theorem. It is shown that an external magnetic field does not alter the form of the theorem. In addition, the real and imaginary part of the conductivity is obtained and shown to be related by a Hilbert transformation; this demonstrates explicitly that the theory satisfies the principle of causality. An extension of the derivation to systems with nonrelativistic electron drift relative to the ions, anisotropic temperature distributions and different electron and ion temperatures does not produce any change in the special Nyquist theorem. The derivation of the special Nyquist theorem for the relativistic domain shows that the basic relationship between the conductivity and the current density fluctuations is modified. In the nondrift case, the relativistic corrections are found to be ~10% of the uncorrected values with T ~ 10^8°K. The special Nyquist theorem for the case of relativistic electron drift velocities is found to depend explicitly on the drift velocity. The derivation of the relativistic relations makes use of the formal properties of relativistic equilibrium distribution functions which are also described. The special Nyquist theorem for the quantum-mechanical domain is obtained by a method originally developed by Callen and Welton for investigating the one-dimensional case. It is found that the quantum-mechanical corrections are the same for the special and conventional Nyquist theorems and that the classical form of the theorem is obtained at sufficiently high temperatures. (Diss. Abstr. Int., B)

13711 ELECTRIC FIELD OF A MOVING TEST CHARGE. Yu, M. Y.; Stenflo, L.; Shukla, P. K. (Univ. of Umea, Sweden). Radio Sci.; 7: No. 12, 1151-2(Dec 1972).

The electric field at large distances from a moving test charge in a collisionless plasma is calculated. Significant differences from the well-known inverse fourth-power dependence of the electric field on the distance between the observer and the charged particle are obtained. (auth)

13712 NUMERICAL SIMULATION OF THE INTERACTION OF A FAST ELECTRON BEAM MOVING THROUGH A BOUNDED PLASMA. Chang, C. S. Houston, TX; Univ. of Houston (1972). 159p. University Microfilms Order No. 72-32,692.

Thesis.

A two-dimensional Particle-In-Cell simulation program which assumes the potential to be equal to zero on the boundary and which allows particle injection and absorption was developed and applied to the study of the Coulomb interaction between an electron plasma and an injected electron beam. The object is to obtain a more realistic simulation of experiments in which electron beams are injected into plasmas. Previous analyses and simulations considered the beam to exist throughout the plasma and use completely periodic boundary conditions which constitute a powerful but unphysical form of feedback, as well as a neglect of possibly dominant initial injection transients. (TSS) (Diss. Abstr. Int., B)

13713 THEORY OF THE UNMAGNETIZED PLASMA. Montgomery, D. C. New York; Gordon and Breach, Science Publishers, Inc. (1971). 408p. $17.50.

The following chapters are presented: (1) Klimontovich and Vlasov models, (2) macroscopic variables and moment equations, (3) linear electrostatic solutions, (4) plasma oscillations, ion acoustic waves, and linear instabilities, (5) external fields; test charges, (6) nonlinear Vlasov phenomena, (7) statistical description of plasmas, (8) kinetic theory of stable uniform plasma, (9) two-time ensemble averages; fluctuation spectra in stable plasma, and (10) kinetic theory of unstable plasma; ensembles of Vlasov plasmas. (M.O.W.)

13714 BEAM–PLASMA INTERACTION AS AFFECTED BY AN AXIAL INHOMOGENEITY. Demchenko, V. V.; El-Siragy, N. M. (Atomic Energy Authority, Cairo). Phys. Lett.; 42A: No. 4, 282-4 (18 Dec 1972).

The effect of axial (with respect to the direction of beam propagation) inhomogeneity on the process of slow surface wave (SW) resonant excitation by a relativistic monoenergetic beam of charged particles is investigated. The allowance for the inhomogeneity is demonstrated to change the natural frequencies of excited SW and thus violate the Cherenkov SW beam resonance. A dispersion equation and growth rates of the excited waves are obtained, taking into account the density inhomogeneity. (auth)

13715 CONCEPTS OF PLASMA TURBULENCE. Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk; 108: No. 1, 143-76(Sep 1972). (In Russian).

The concepts of elementary excitation in the theory of plasma

turbulence are reviewed: plasma turbulence is compared with turbulence in incompressible liquids; balance equations and formulas describing collisions are presented for turbulent plasmas. Stochastic potentials and their amplitudes are analyzed. Quasi-linear approximation and nonlinear diffusion of particles, and nonlinear dispersion with stochastic heating are treated. One section explores effective turbulent encounters for particle–wave interactions, irreversibility in plasma turbulence theory, and the evaluation of frequencies of turbulent collisions. A final section focuses attention on turbulent broadening of the resonances of nonlinear decomposition reactions and the correlation functions of turbulent plasma. (60 references) (K.S.W.)

13716 COLLISIONAL DIFFUSION IN A TOROIDAL PINCH. Wakatani, M.; Itatani, R. (Kyoto Univ.). J. Phys. Soc. Jap.; 34: No. 1, 181-8(Jan 1973).

Transverse diffusion coefficients in a toroidal pinch are investigated for three regions of collision frequencies. The configuration of a toroidal pinch is characterized by a large poloidal magnetic field B_P comparable to a toroidal magnetic field B_T. Diffusion coefficients were calculated following the scheme of Galeev and Sagdeev. In a toroidal pinch, particles can be trapped in a local magnetic mirror formed by both a toroidal magnetic field and a poloidal magnetic field. Furthermore, $B_P \simeq B_T$ reduces the connection length of a toroidal pinch. Transverse diffusion coefficients, including these effects, are shown to be smaller than D_{GS} which is given by Galeev and Sagdeev. In the banana region $D_\perp \simeq D_{GS}\sqrt{\delta/\epsilon}$ is obtained and in the plateau region $D_\perp \simeq D_{GS}(\delta^2/\epsilon^2)$, where ϵ denotes an aspect ratio and a small parameter δ denotes the inhomogeneity of the toroidal magnetic field in the toroidal pinch. Here it is noted that a safety factor included in $D_\perp$ may be smaller than or comparable to unity. In the MHD region $D_\perp$ also includes a factor δ/ϵ. (auth)

13717 VALIDITY CRITERIA FOR LOCAL THERMODYNAMIC EQUILIBRIUM AND CORONAL EQUILIBRIUM. Fujimoto, T. (Kyoto Univ.). J. Phys. Soc. Jap.; 34: No. 1, 216-24(Jan 1973).

LTE and CE are treated on the basis of the collisional-radiative model for hydrogenic ions in plasma. Approximate forms of the coefficients of the quasi-steady-state solution in the model lead to validity criteria as well as their numerical expressions for the equilibria. A set of criteria for partial LTE is derived, which consists of those proposed by Griem and by Byron et al. and of the ones concerning the state of ionization. The criterion for complete LTE is identical with that by Griem. Two criteria for CE are obtained that reduce to those proposed by Wilson and by McWhirter. Effect of radiation trapping of Lyman lines is estimated, and it is shown that the criteria for partial LTE are little relaxed, but that for complete LTE is much affected for $T_e/z^2 \lesssim 1 \times 10^4$ K. (auth)

13718 KINETIC THEORY OF ELECTROMAGNETIC FLUCTUATIONS IN ANISOTROPIC PLASMA HALF-SPACE. Genchev, Zh. D.; Kalmykova, S. S. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 9, 1355-61(1972). (In Russian).

The electromagnetic-field fluctuations in a semi-bounded homogeneous collisionless plasma with a surface of mirror reflection are considered, taking into account the defects of spatial dispersion. The external magnetic field perpendicular to the plasma-vacuum interface is assumed to be infinitely strong, $\omega_{ce}^2 \gg \omega^2 \sim \omega_{pe}^2 \gg \omega_{ce}\omega_{ci}$. The correlator of Fourier components of random inductions is obtained. The correlation function of the electric-field intensity in plasma is calculated by means of the correlator and investigated. (tr-auth)

13719 TRANSPORT PROPERTIES OF PARTIALLY IONIZED GASES. Miller, E. J. Newark, DE; Univ. of Delaware (1972). 227p. University Microfilms Order No. 72-32,007.

Thesis.

Transport properties of partially ionized gases are calculated from the perturbed Lorentzian solution of the Boltzmann kinetic equation. The basic idea of this solution is that the velocity distribution function of the electrons is computed as a perturbation to the distribution function for a Lorentzian mixture. The transport properties of both partially ionized argon and helium plasmas at 1 atm pressure are calculated by the perturbed Lorentzian method and compared with the equivalent Chapman–Enskog calculations. For both gases the perturbed Lorentzian method converges more rapidly than the Chapman–Enskog method at low degrees of ionization. This is especially true for an argon plasma since the occurrence of the Ramsauer minimum in electron–atom cross sections causes very slow convergence of the Chapman–Enskog solution. Though the Chapman–Enskog convergence at low degrees of ionization is sensitive to the energy dependence of the electron–atom cross section, the perturbed Lorentzian method converges well regardless of the form of this cross section. Charged-particle interactions are treated accurately by including dynamic shielding effects in Chapman–Enskog calculations. Results of such transport property calculations are in good agreement with those assuming static shielding by electrons but no shielding by ions. Momentum-transfer frequencies are used to establish a well-defined ordering procedure for the Boltzmann equations of a partially ionized gas. The ordered equations permit solutions for the velocity distribution functions in a plasma in which the electrons and heavy particles have different temperatures. All species, however, have the same macroscopic velocity. Solution of the ordered equations for two-temperature argon plasmas was accomplished by both Chapman–Enskog and perturbed Lorentzian methods. The convergence problems that exist in the Chapman–Enskog solution for the isothermal plasma also exist for the two-temperature plasma. These convergence problems are eliminated by using the perturbed Lorentzian solution. The Ramsauer minimum in the electron–atom cross sections causes the electrical conductivity to decrease with an increase in electron temperature at low (and constant) degrees of ionization. At higher degrees of ionization the electrical conductivity increases with increasing electron temperature. The perturbed Lorentzian and Chapman–Enskog results appear to have the useful property of bracketing the actual values of the transport coefficients. (Diss. Abstr. Int., B)

13720 NONLINEAR FLUCTUATION–DISSIPATION THEOREM. Golden, K. I. (Northeastern Univ., Boston); Kalman, G.; Silevitch, M. B. J. Statist. Phys.; 6: No. 2-3, 87-118(1972).

Using statistical mechanical perturbation theory, the second-order average current density response is calculated for magnetic field-free classical plasmas. A dynamical fluctuation–dissipation theorem is then derived, thus establishing a connection between triplet microscopic current–current correlations and quadratic response functions; it also leads to a static fluctuation-dissipation theorem which provides a dielectric description of the equilibrium ternary correlation. A comparison of the latter with its expansion in terms of the Mayer pair correlation clusters is discussed. (auth)

13721 CHERENKOV RADIATION IN A DRIFTING MAGNETO-PLASMA. Agarwal, D. C. (Univ. of Allahabad, India). Indian J. Phys.; 46: No. 3, 109-13(Mar 1972).

The theory of Cherenkov radiation from electrons in a drifting magnetoplasma is considered. The variation of the total Cherenkov power radiated by these electrons for certain frequency, electron density, and collision frequency models, is calculated. It is concluded that, for low frequency, the Cherenkov radiated power is reduced with the increase of collision frequency whereas, for high frequency, the collision frequency effects are considerably smaller. Also, it decreases with the increase in drift velocity, since the refractive index of such plasma then decreases. (auth)

13722 DIELECTRIC FORMULATION OF TEST PARTICLE ENERGY LOSS IN A PLASMA. Silevitch, M. B.; Golden, K. I. (Northeastern Univ., Boston). J. Statist. Phys.; 7; No. 1, 65-87(Jan 1973).

Using a perturbation-theoretic method which starts from a microscopic Newtonian equation of motion for the trajectory of a test particle moving in a magnetic field-free plasma, the polarization and statistical contributions to the test charge energy loss are formulated entirely in terms of linear and quadratic dielectric functions. (auth)

Production

13723 (CEA-R-4379) EXPERIMENTAL ASPECTS OF RADIATION-PLASMA INTERACTIONS. Piar, Georges (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Dec 1972. 61p. (In French). Dep. NTIS (U. S. Sales Only).

A laser–matter interaction experiment is described that gave evidence for nuclear fusion reactions during the plasma creation. Some stimulated and nonlinear effects never seen before are examined. (auth)

13724 SIMPLE BAKEABLE HOLLOW CATHODE DEVICE FOR THE DIRECT STUDY OF PLASMA CONSTITUENTS. Maerk, T. D.; Lindinger, W.; Howorka, F.; (and others) (Univ., Innsbruck). Rev. Sci. Instrum.; 43: No. 12, 1852-3(Dec 1972).

The unique features of construction of a hollow cathode discharge apparatus are described. The device includes a highly important exit aperture that also serves as a Langmuir probe for exploring the negative glow plasma. (auth)

13725 PRODUCTION OF HOT PLASMAS OF SOLID-STATE DENSITY BY ULTRASHORT LASER PULSES. Salzmann, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). J. Appl. Phys.; 44: No. 1, 113-24(Jan 1973).

Ultrashort laser pulses emitted by a neodymium glass laser system were focused on the surface of solid targets situated in a high-vacuum environment. The laser pulse duration as measured by the two-photon fluorescence technique was less than 10^{-11} sec. Pulse energies up to 3J were obtained corresponding to a maximum energy release of 3×10^4 J cm^{-2} in the focal area. The plasmas produced from targets of solid deuterium, carbon, and thin foils of Mylar were investigated by x-ray measurements, time-of-flight measurements using charge collecting probes, and, in the case of deuterium, by neutron counting measurements. Only 10% of the incident light energy was found to be reflected from the targets. Electron temperatures of 500 and 200 eV were measured for deuterium and carbon plasmas, respectively. The experimental results are found to be consistent with the predictions of the model of a thermal wave penetrating into the solid. (auth)

13726 PRODUCTION OF A PLASMA BY MEANS OF LASERS. Ehlers, K. W.; Brown, I. G.; Lietzke, A. F. (to United States Atomic Energy Commission). German Patent 2,205,236. 24 Aug 1972. (In German).

A device is proposed that consists of magnetic confinement, lasers, optical systems, and electric circuits. The components are arranged to achieve the following procedure: a dropping fuel particle (e.g., pellet) consisting of solid hydrogen triggers via detectors, multipliers, ignition circuits, etc., a laser which is focused on the pellet. (GF)

Stability

Refer also to abstracts 13657, 13658, 13662, and 13663.

13727 (AD-744818) EXPERIMENTAL STUDY OF INSTABILITIES IN THE ELMAX. Trouy, V. R. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 52p. (GEP/PH-72-22). NTIS.

An experimental search for instabilities in an ELMAX plasma device was made. Plasma generated oscillations of potential and density, with amplitudes several orders of magnitude above background noise, were observed over a wide range of plasma parameters. Measurements of plasma parameters were made with Langmuir probe techniques. Frequencies from 3 to 8 kHz were observed with phase velocity in the direction of the electron diagmagnetic drift. Ion temperature was not measured, and attempted measurements of space potential were not satisfactory. By comparing the observed characteristics of the oscillations with previously identified instabilities, the instabilities responsible for the plasma-generated oscillations were tentatively identified as collisional drift waves. (auth)

13728 (AD-746109) LOW FREQUENCY PARAMETRIC INSTABILITIES OF MAGNETIZED PLASMAS WITH TWO ION SPECIES. Ott, Edward; McBride, J. B.; Orens, J. H. (Naval Research Lab., Washington, D. C.). Jul 1972. 29p. (NRL-MR-2460). NTIS.

A theoretical and computer simulation treatment is presented of the response of magnetized plasmas with two ion species to low frequency, electric fields oscillating at ω_0 near the lower hybrid frequency, ω_{LH}, that shows the existence of parametric instabilities. A decay instability involving the Buchsbaum two-ion resonance occurs for $\omega_0 > \omega_{LH}$, and a purely growing instability occurs for $\omega_0 < \omega_{LH}$. The analysis is valid even when the masses of the ion components are comparable and applies, for example, to deuterium–tritium plasmas. Computer-simulation experiments demonstrate the potential importance of these instabilities as ion-heating mechanisms. (auth)

13729 (MATT-939) LINEAR THEORY OF PARAMETRIC INSTABILITIES IN PLASMA. Porkolab, Miklos (Princeton Univ., N. J. Plasma Physics Lab.). Nov 1972. Contract AT(11-1)-3073. 33p. (CONF-720961-3). Dep. NTIS.

From Symposium on plasma heating and injection; Varenna, Italy (24 Sep 1972).

The linear theory of parametric instabilities is reviewed. The general dispersion relation is derived from the Vlasov equation. The dispersion relation is analyzed in terms of the linear dielectric function and its derivatives. The thresholds and growth rates for the decay instability, the purely growing mode, and the kinetic instability are obtained. The analysis is applied to discuss some specific modes, such as the interaction of electron plasma waves and the ion acoustic waves, the upper hybrid and the lower hybrid modes, Bernstein waves and ion acoustic waves, and the decay of the whistler wave and the lower hybrid wave. (auth)

13730 INSTABILITY OF A RELATIVISTICALLY STRONG ELECTROMAGNETIC WAVE OF CIRCULAR POLARIZATION. Max, C.; Perkins, F. (Princeton Univ., NJ). Phys. Rev. Lett.; 29: No. 26, 1731-4(25 Dec 1972).

It is demonstrated that a circularly polarized electromagnetic wave propagating through a cold plasma and strong enough to make electrons relativistic ($\nu_0 \equiv eE_0/m_e c\omega_0 \gtrsim 1$) is subject to a new pinching type of instability. The linearized equations are solved exactly, without the necessity of introducing an infinite determinant. This allows the results to describe the transition from nonrelativistic to extreme-relativistic electron motion. In the relativistic limit, the growth rates are as high as $0.47\omega_0$. (auth)

13731 SECOND-ORDER EFFECTS IN THE WEIBEL INSTABILITY. Taggart, K. A.; Godrey, B. B.; Rhoades, C. E. Jr.; Ives, H. C. (Air Force Weapons Lab., Kirtland Air Force Base, NM). Phys. Rev. Lett.; 29: No. 26, 1729-31(25 Dec 1972).

Observations of anomalous growth of electrostatic modes in computer simulations of the Weibel instability have led to the formulation of a second-order analytic description of the coupling of transverse magnetostatic modes to longitudinal electrostatic modes. Comparison of the theoretical values for the coupling constants with those measured in numerical experiments shows agreement to within 5% for both magnitude and phase. (auth)

13732 SPECTRAL-LINE STRUCTURES OF SATURATED PARAMETRIC INSTABILITIES. Kuo, Y.-Y.; Fejer, J. A. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett.; 29: No. 25, 1667-70(18 Dec 1972).

The nonlinear saturation spectrum of parametric instabilities is shown to be restricted to discrete values of the propagation vector if spontaneous emission is neglected and a one-dimensional analysis is used. The purely growing instability is not excited for equal ion and electron temperatures if the power is less than 3.5 times the threshold power. The inadequacy of the present one-dimensional treatment is pointed out, and it is shown that waves with propagation vectors that are not parallel to the pump field must be present even if spontaneous emission is neglected. (auth)

13733 NONLINEAR THEORY OF DISSIPATIVE INSTABILITY OF A RELATIVISTIC BEAM IN A PLASMA. Abramovich, V. U.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 329-32(Feb 1972). (In Russian).

The dissipative instability of a relativistic beam in a plasma was investigated with partial collisions $\nu > \delta$ (where δ = the increment of beam instability), both in the absence and in the presence of a strong magnetic field. Quasi-linear approximation equations were used for investigating the instability, since the increment of oscillation growth is related to a broad range of wavelengths. During the development of dissipative instability, the energy lost by the beam goes mainly into collision heating of the electrons of the plasma. In the case of spectrum anisotropy during the interaction of a relativistic beam with a plasma without a magnetic field; the spectrum is practically isotropic during dissipative instability. (tr-auth)

13734 PLASMA DIFFUSION IN THE DEVELOPMENT OF DRIFT-DISSIPATIVE INSTABILITY. Naumovets, V. G.; Pasechnik, L. L.; Popovich, A. S. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 332-4(Feb 1972). (In Russian).

The effect of oscillations associated with the excitation of drift-dissipative instability in a gas-discharge plasma during diffusion of electrons and ions across the magnetic field is investigated. The diffusion time is determined by the phase method. The diffusion coefficient values are between those of calculations based on quasi-linear estimates ($\gamma \ll \omega$) and estimates derived from strong turbulence ($\gamma \sim \omega$). For a more precise calculation, the increment of development of instability γ, the diffusion coefficient, and the effect of end conditions on the oscillation amplitude must be accounted for. (tr-auth)

13735 ELECTRON CYCLOTRON DRIFT INSTABILITY EXPERIMENT. Ripin, B. H.; Stenzel, R. L. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 30: No. 2, 45-8(8 Jan 1973).

The electron cyclotron drift instability was observed in a controlled, steady-state experiment. Enhanced noise bands are seen in the first two Bernstein wave dispersion branches. Dispersion, noise frequency dependence upon magnetic field and ion beam velocity, and saturation are demonstrated. (auth)

13736 STABILIZATION OF EXPLOSIVE INSTABILITIES BY NONLINEAR FREQUENCY SHIFTS. Oraevskii, V. N. (Inst. of Nuclear Research, Kiev); Pavlenko, V. P.; Wilhelmsson, H.; Kogan, E. Ya. Phys. Rev. Lett.; 30: No. 2, 49-51(8 Jan 1973).

It is found that nonlinear frequency shifts proportional to the square of the amplitudes of the waves may lead to a soliton-type solution in time for stabilized explosive instabilities. (auth)

13737 OBSERVATION OF EXPLOSIVE INSTABILITY OF PARAMETRICALLY COUPLED WAVES. Kiyashko, S. V.; Rabinovich, M. I.; Reutov, V. P. (Inst. of Radio Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 271-3 (5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 384-7(5 Oct 1972).

An experimental investigation of explosive instability of electromagnetic waves is described. Explosive instability was observed in a nonlinear medium in the radio band in a two-wire transmission line with nonlinear leakage, in which the dependence of the current on the voltage was in the form $j = -\sigma_1 u^2$. The nonlinear-leakage elements were tunnel diodes whose operating points were at the maxima of the characteristics. Diagrams of the wave-coupling processes are given. (MOW)

Thermonuclear Engineering and Equipment

Refer also to abstract 12684.

13738 (CEA-CONF-2107) PRODUCTION OF PULSED HIGH MAGNETIC FIELDS WITH ROTATING MACHINE. Rebut, P. H.; Torossian, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Delassus, J.; Delaunay, M. [nd]. 5p. (CONF-720908-31). Dep. NTIS (U. S. Sales Only).

From 4th international conference on magnet technology; Upton, NY (19 Sep 1972).

A power source delivering a mean power of 100 MW over a pulse duration of 1.5 s to the main toroidal magnet of the TFR experiment is described. The power source includes an asynchronous motor of 1.2 MW running up to 1500 rpm and driving through a gear box a flywheel storing 400 MJ at 6000 rpm. The energy is delivered to the load through a 150-MVA diode rectifier. (auth)

13739 (CEA-CONF-2108) A LARGE 100 MW PULSED MAGNETIC COIL FOR FUSION RESEARCH. Huguet, M.; Rebut, P. H.; Torossian, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Meier, M. [nd]. 8p. (CONF-720908-30). Dep. NTIS (U. S. Sales Only).

From 4th international conference on magnet technology; Upton, NY (19 Sep 1972).

The main toroidal magnet for the TFR fusion device now being assembled at Fontenay-aux-Roses is described. The magnet consists of a 98-cm major-radius and 30-cm minor-radius torus. It is composed of 24 oil-cooled Bitter-type coils. Each coil consists of 35 turns of full hard copper insulated with kapton. The total weight of the 24 coils is about 20 tons. A center line field of 69 kG is generated with a current of 35,000 A. The field corrugations along the center line do not exceed 0.5%. With a peak power input of 120 MW and for a mean pulse length of 1.5 s, the energy delivered to the magnet during one pulse is 150 MJ, and the magnetic energy stored is 40 MJ. The repetition rate is one pulse every 4 minutes. (auth)

13740 (CONF-721058-1) DESIGN CONSIDERATIONS FOR DIVERTORS IN TOROIDAL FUSION REACTORS. Tenney, F. H.; Lewin, G. (Princeton Univ., N. J. Plasma Physics Lab.). [nd]. Contract AT(11-1)-3073. 6p. Dep. NTIS.

From seventh symposium on fusion technology; Grenoble, France (24 Oct 1972).

It is well-known that a divertor would be a desirable feature of a toroidal reactor. A conceptual design of an axisymmetric poloidal field divertor for a Tokamak reactor is discussed. The design has the advantage that the divertor coils are located outside of both the blanket and the divertor chamber. The total wall area is approximately equal to the reactor wall area. The hot ions streaming into the divertor initiate a wall–plasma interaction producing neutrals which, in turn, are ionized and form a relatively cold plasma. The cold plasma cannot be contained in the divertor; its temperature must be kept below 25 eV to prevent excessive wall erosion. (auth)

13741 (CONF-721111-17) PRINCETON REACTOR STUDIES PROGRAM. Mills, R. G. (Princeton Univ., N. J. Plasma Physics Lab.). 1972. Contract AT(11-1)-3073. 14p. Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

The history, composition, and philosophy of the Princeton Reactor Studies Program are described. The problems besetting a realistic fusion power station are summarized, and the principal features of a reference design for a first-generation reactor are presented. Current program results are related to needs for experimental work and their possible effects on future reactor studies. (auth)

13742 (CONF-730103-1) ENGINEERING PROBLEMS IN THE DESIGN OF CONTROLLED THERMONUCLEAR REACTORS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). 1972. 11p. Dep. NTIS.

From AIAA 11th aerospace sciences meeting and technical display; Washington, D. C. (10 Jan 1973).

In the past few years the work on the plasma physics of controlled thermonuclear reactors has progressed sufficiently to make it possible to prepare some conceptual designs that point up the engineering problems that must be confronted when feasibility is demonstrated, hopefully about 1980. The studies have disclosed that a large set of boundary conditions must be satisfied, and meeting these with a well-balanced integrated design presents an exceptionally challenging set of problems. These include 30- to 70-kG superconducting magnet coils 10 m in diameter, two-phase heat transfer and fluid flow of liquid helium, 4°K helium refrigeration systems, magnetohydrodynamic effects on pumping power and heat transfer for large ducts carrying lithium at 1000°C in a niobium–zirconium alloy blanket structure, sputtering and radiation damage to the wall confining the plasma, and potassium–steam binary vapor cycle power conversion systems with a peak temperature of about 1000°C and a thermal efficiency approaching 60%. (auth)

13743 (FUPH-G-2) PROGRESS REPORT ON CONTROLLED FUSION RESEARCH. Brennan, M. H. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Oct 1972. 26p. Dep. NTIS (U. S. Sales Only).

For Australian Atomic Energy Commission.

A survey is made of the international research program directed towards the development of a controlled thermonuclear fusion reactor. The basic requirements of a fusion reactor are briefly summarized, and the current state of fusion research is reviewed. A short review of the fifth European conference on controlled fusion and plasma physics is given. (Austria)

13744 (JUL-860-PP) CALCULATION OF HELICAL VACUUM-MAGNETIC FIELDS FOR HIGH-β-STELLARATORS. Mioduszewski, P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Jun 1972. 27p. (In German). Dep. NTIS (U. S. Sales Only).

In the stellarator, toroidal equilibrium is obtained by the addition of helical magnetic fields to the basic θ-pinch field. Helical fields generated by external windings are calculated from the scalar magnetic potential ϕ. A general expression of ϕ for fields of l-fold symmetry is given. The l = 1-field is investigated in detail. The influence of the image currents in an outer conducting wall (compression coil) on the magnetic field and the inductance is studied. (auth)

13745 (LA-5121) REFERENCE THETA PINCH REACTOR (RTPR): A STUDY OF A PULSED HIGH-BETA FUSION REACTOR BASED ON THE THETA PINCH. Burnett, S. C.; Ellis, W. R.; Oliphant, T. A.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). Dec 1972. Contract W-7405-eng-36. 36p. Dep. NTIS.

A design study of a pulsed high-beta θ-pinch reactor is presented. In the reference design developed here, the reactor generates 1.8 GWe with a duty factor chosen to limit the first wall nuclear power loading to 3.5 MW/m^2. Magnetic energy is switched reversibly into the compression coil from a cryogenic magnetic energy store situated outside the reactor core. The compression coil is protected from excessive nuclear radiation and heating by a portion of the neutron-moderating, tritium-breeding blanket. The blanket, in its present configuration, operates at a temperature of 800°C and has a breeding ratio of about 1.12. Flushing of ^{4}He and refueling between burning pulses is accomplished by flowing D–T gas through the discharge chamber. Some advantages of pulsed systems with respect to steady-state systems are discussed. Energy flow in the reactor is calculated, and it is shown that the circulating power fraction for the total system is approximately 10%. (auth)

13746 (LA-DC-72-1378) LASER CTR SYSTEMS STUDIES. Williams, J. M. (Los Alamos Scientific Lab., N. Mex.). 1972. 27p. (CONF-721111-14). Dep. NTIS.

From international meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

LASL Laser-initiated Controlled Thermonuclear Reactor (LCTR) engineering systems studies are described. Design considerations are discussed in the following generalized areas of laser-driven fusion reactor design: (1) Beam transport, (2) Pellet fabrication and delivery, (3) Beam/pellet coupling, (4) Energy collection and conversion, and (5) Containment and shielding. The lithium-wetted wall, laser-driven fusion reactor concept studied at LASL, is described and major design features are reviewed. Plans for study of other conceptual laser CTR systems are briefly summarized. (auth)

13747 (LA-DC-72-1389) SCYLLAC MHD FEEDBACK SYSTEM. Gribble, R. F. (Los Alamos Scientific Lab., N. Mex.). 1972. 15p. (CONF-721111-9). Dep. NTIS.

From international meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

The plasma position of the 15-m circumference Scyllac toroidal experiment is to be feedback controlled with 1-GW of vacuum tube power amplifiers. The plasma body force for feedback plasma position control is obtained from a combination of $l = 1$ helical fields obtained from grooving the θ-pinch coil and amplifier controlled, $l = 0$ bumpy magnetic fields. Optically derived plasma position signals are specially processed before transmission to 90-power amplifier modules each of which has a transformer-coupled output to two bucking $l = 0$ coils of ±7 kA at 4 kV. From detector to power module output the delay plus risetime is 1.3 μsec, depending on the output transformer turns ratio. All of the system power supplies are voltage regulated with current limiting. A feedback system consisting of 10 power modules has been operated with the Scylla IV-3 experiment. (auth)

13748 (LA-DC-72-1397) PARAMETER STUDY OF A PULSED HIGH-BETA FUSION REACTOR BASED ON THE THETA PINCH. Burnett, S. C.; Ellis, W. R.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). 1972. 23p. (CONF-721111-5). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

A pulsed, high-beta, deuterium–tritium plasma is taken as the energy source of a 1.8-gigawatt electric power plant. In the reactor core the plasma (density 10^{16} cm^{-3}, temperature 15 to 25 keV, radius 15 cm) is surrounded by a thin vacuum wall at 30 cm which also serves as a shock-heating coil. This coil is driven by high-voltage circuits whose energy content is only a few percent of that of the total system. The low voltage compressional and confining magnetic field, whose energy is preponderant, has a risetime of a few milliseconds, and is generated by a multiturn copper coil whose radius is ~3 times that of the shock-heating coil. The compression coil operates near room temperature and is sufficiently economical of joule losses that they can be made up by direct energy conversion from the expansion of the high-beta plasma against the magnetic field during the burning pulse. The compression coil is protected from excessive nuclear radiation and heating by a portion of the neutron-moderating, tritium-breeding blanket. The blanket operates at a temperature of 700 to 800°C and has a breeding ratio of ~1.12. Magnetic energy is switched reversibly into the compression coil from a cryogenic magnetic energy store situated outside the reactor core. The compression magnetic energy is returned to the store at the end of each power pulse, which lasts 100 ms. These pulses are separated by 10 seconds. The plasma parameters and duty factor are chosen to limit the first-wall nuclear loading to ~3.5 MW/m^2, corresponding to reasonable heat-transfer, temperature rise, and radiation damage. Fueling and flushing of the plasma between burning pulses can probably be accomplished by flowing D–T gas through the discharge chamber. During this fuel recycling process heat transfer from the plasma to the first wall depends primarily on atomic thermal transport and optical radiation in the region of neutral gas and partially ionized plasma surrounding the core. (auth)

13749 (LA-DC-72-1400) STAGED THETA PINCHES WITH IMPLOSION HEATING. Freidberg, J. P.; Morse, R. L.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). 1972. 27p. (CONF-721111-8). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

Present θ-pinch experiments involve high-β plasmas with area compression ratios of the order of 40, using high-voltage capacitors to provide both the early implosion heating, during the first few tenths μsec, and the later adiabatic compression in a single-turn coil. In the staged θ-pinch concept the implosion heating is done by high-voltage circuits whose energy content is only a small fraction of that of the total system. The compression magnetic energy, which is preponderant, is contained in a coil with slow risetime, appropriate to adiabatic compression of the plasma in large systems. The compression energy can then be applied by economical magnetic-energy-storage systems. The mixture of implosion- and adiabatic-compression heating can be adjusted to give final-area compression ratios less than 10. The staged heating is calculated on the basis of plasma sheaths driven by high-voltage transmission lines, followed by equilibration of ion and electron temperatures and $\gamma = 5/3$ adiabatic compression. Plasma-simulation studies of the implosion-heating process show that radial compression ratios as large as ~0.9 can be obtained by programming the implosion-heating fields. (auth)

13750 (LA-DC-72-1407) FUSION REACTOR SYSTEMS. Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). 1972. 28p. (CONF-721109-14). Dep. NTIS.

From International conference on nuclear solutions to world energy problems; Washington, D. C. (12 Nov 1972).

A survey of the four different types of D–T fusion reactors is presented: tokamaks, theta pinches, magnetic mirrors, and the laser–pellet concept. The principles of operation and design concepts for each type are discussed. (M.O.W.)

13751 (LA-DC-72-1427) DISCRETE-ORDINATES NEUTRONIC ANALYSIS OF A REFERENCE THETA-PINCH REACTOR (RTPR). Dudziak, D. J. (Los Alamos Scientific Lab., N. Mex.). 1972. 22p. (CONF-721111-7). Dep. NTIS.

From international meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

Neutronic analysis of the current Los Alamos RTPR has provided neutron flux and reaction rate distributions throughout the blanket. Transport calculations were performed in 1-D cylindrical geometry, using S_4 quadrature and 100-group, P_3 cross sections. A tritium breeding ratio of 1.12 was derived from the computed reaction rates, as adjusted for estimated resonance self-shielding effects in the niobium. Displacements per atom (dpa) and He production, important effects in radiation damage, were determined for the Nb structure. A first-wall loading of 3.5 MW/m^2 gives 59 dpa/yr and 97 ppM He/yr, comparable to other CTR's. Average energy deposition in the Cu compression coil from neutron and gamma-ray interactions is approximately 0.17 W-cm^{-3}, allowing reasonable cooling system parameters. (auth)

13752 (LA-DC-72-1473) CONTEMPORARY CAPACITIVE ENERGY STORAGE SYSTEMS. Kemp, E. L. (Los Alamos Scientific Lab., N. Mex.). [nd]. 3p. (CONF-721202-7). Dep. NTIS.

From Nuclear science symposium and exhibits: nuclear instrumentation for research and development; Miami Beach, FL (6 Dec 1972).

Capacitive energy storage is one of the oldest forms of energy storage for pulsed power requirements. Most energy storage capacitors are made of Kraft paper and aluminum foil and impregnated with castor oil. A typical capacitor stores ~3000 joules at voltage ratings of 5 to 100 kV. Two types of switches are used for capacitor bank switching, ignitrons and pressurized spark gaps. Ignitrons are commercially available, have a wide voltage operating range and are easy to trigger. However, they are limited to ~20 kV for most applications and they will prefire. Spark gaps can be designed for reliable operation at almost any voltage level but they are rarely commercially available. Most spark gaps do not operate satisfactorily below 50% of their design voltage and they require a more complicated trigger system than ignitrons. Low inductance coaxial cable has been developed for capacitor bank transmission systems. It is relatively inexpensive and commercially available. Parallel plate transmission lines can be designed to accumulate large amounts of current and conduct it to a concentrated load but careful attention must be given to the containment of the magnetic forces involved. Large numbers of ignitrons can be triggered with a simple trigger circuit that will be described. A circuit is also given to automatically trigger a crowbar ignitron. A pulse forming network circuit is presented which uses inductive voltage addition to generate an 800-kA pulse rising in 100 nsec with a pulse length of 500 nsec. (auth)

13753 (UCID-15386) HEAT PIPES AS A MEANS OF ENERGY REMOVAL FROM THERMONUCLEAR REACTOR VACUUM WALLS. Werner, R. W. (California Univ., Livermore. Lawrence Livermore Lab.). 24 Jul 1972. 16p. Dep. NTIS.

Incident flux limits imposed by heat transfer considerations on

vacuum walls of thermonuclear reactors are discussed. The use of heat pipes for energy removal indicates that fluxes of ~500 w/cm^2 can be achieved as compared with ~250 w/cm^2 for conventional cooling. Limiting conditions for heat pipes are considered. Lithium is shown to be a good choice as a heat pipe fluid with sodium second. (auth)

13754 (UCRL-74054) PROGRESS REPORT NO. 1 ON THE DESIGN CONSIDERATIONS FOR A LOW POWER EXPERIMENTAL MIRROR FUSION REACTOR. Werner, R. W.; Carlson, G. A.; Hovingh, Jack; Lee, J. D.; Peterson, M. A. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Nov 1972. 94p. (CONF-721111-13). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

The design of a 200-MWe mirror fusion reactor is discussed. The orderly development of a consistent set of plasma parameters forms the basis for design. This first report of a series places major emphasis on developing the interaction parameters between system elements and components. Items discussed include blanket thermal-hydraulic design, tritium recovery, neutronics, considerations in expander and collector design, and neutron streaming. (auth)

13755 (UCRL-74057(Rev.1)) SOME PROBLEMS ASSOCIATED WITH TRITIUM IN FUSION REACTORS. Hickman, R. G. (California Univ., Livermore. Lawrence Livermore Lab.). 15 Sep 1972. 46p. (CONF-721111-16). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

A number of problems associated with the use of tritium in fusion reactors are yet to be considered. Some are peculiar to mirror machines and attempts at direct conversion of plasma energy to electricity, while others are of general concern. Several of these are considered from the point of view of one who has worked with tritium for several years. Specific areas mentioned include liquid-phase mass transfer of tritium in liquid lithium, isotopic separation, preliminary calculations on permeation barriers, isotopic swamping, and some thoughts on maintenance. (auth)

13756 (UCRL-74057(Rev.2)) SOME PROBLEMS ASSOCIATED WITH TRITIUM IN FUSION REACTORS. Hickman, R. G. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Oct 1972. 48p. (CONF-721111-11). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

A number of problems associated with the use of tritium in fusion reactors are yet to be considered. Some are peculiar to mirror machines and attempts at direct conversion of plasma energy to electricity, while others are of general concern. Several of these are considered from the point of view of one who has worked with tritium for several years. Specific areas mentioned include liquid-phase mass transfer of tritium in liquid lithium, isotopic separation, preliminary calculations on permeation barriers, isotopic swamping, and some thoughts on maintenance. (auth)

13757 (UCRL-74096) DESIGN STUDY OF A 14,000-AMPERE INJECTION SYSTEM FOR A FUSION REACTOR. Hamilton, G. W.; Osher, J. E. (California Univ., Livermore. Lawrence Livermore Lab.). 23 Aug 1972. 20p. (CONF-721111-15). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

The design study presented indicates that the injection and trapping of steady-state beams of the order of 14,000 A into a fusion reactor should be feasible under present technology, using negative ions (D^-, T^-, and/or He^-) injected along a magnetic guide field. Each component of the proposed 14,000-A system is based upon technology proven at various laboratories by design studies and by operating apparatus. The only required assumptions are the increase of areas of existing sources and beams and the scientific feasibility of the reactor itself. The techniques can be applied to either a mirror fusion reactor or to a toroidal reactor with the guide field built into a diverter. It appears that the remaining questions on reactor injection are associated with economics and power balance, but not with feasibility. (auth)

13758 (UCRL-74096(Rev.1)) DESIGN STUDY OF A 14,000-AMPERE INJECTION SYSTEM FOR A FUSION REACTOR. Hamilton, G. W.; Osher, J. E. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Oct 1972. 37p. (CONF-721111-10). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX (20 Nov 1972).

A design study is presented which indicates that the injection and trapping of steady-state beams of the order of 14,000 A into a fusion reactor should be feasible under present technology using negative ions (D^-, T^- and/or He^-) injected along a magnetic guide field. Each component of the proposed 14,000-A system is based upon technology proven at various laboratories by design studies and by operating apparatus. The only required assumptions are the increase of areas of existing sources and beams and the scientific feasibility of the reactor itself. The major components are the following: (1) a wide-area source of negative ions; (2) an acceleration system operating under modest requirements of beam density and optics; (3) a magnetic guide field in which the beam density is increased by a factor of 100 or more; and (4) the reactor plasma in which the negative ions are subjected to final acceleration, neutral atom production and trapping, with a trapped fraction up to 84%. The techniques can be applied to either a mirror fusion reactor or to a toroidal reactor with the guide field built into a diverter. It appears that the remaining questions on reactor injection are associated with economics and power balance, but not with feasibility. (auth)

13759 MIRROR REACTOR FEASIBILITY COMPARISON WITH TOKAMAK REACTOR. Golovin, I. N. (Inst. of Atomic Energy, Moscow). pp 1.1-7 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Plasma confinement data are compared for tokamaks and mirror machines. The pecularities of power cycles and blankets for each are discussed along with areas of future work. (M.O.W.)

13760 ECONOMIC CONSIDERATIONS AND MAGNETIC ENERGY STORAGE FOR HIGH-β, PULSED REACTORS. Ribe, F. L. (Los Alamos Scientific Lab., NM). pp 1.13-18 of Energy 70, Proceedings, Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

In the pulsed, high-β reactor model a gas-cooled (or Li-cooled) Mo coil inside a Li blanket contains the magnetic compression field, allowing ample tritium regeneration. The margin M of energy balance over losses is evaluated and the corresponding circulating-power fraction M^{-1} is calculated. An economic comparison is made with a standard steady-state reactor. Methods of cryogenic magnetic energy storage for a pulsed reactor are also discussed. (auth)

13761 REVIEW OF THE ORNL FUSION FEASIBILITY STUDIES. Steiner, Don (Oak Ridge National Lab., TN). pp 1.29-35 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The conceptual fusion reactor that has been the basis for the ORNL investigations is described; then the scope of the ORNL studies is discussed briefly; next, the ORNL investigations in the areas of radiation damage, environmental considerations, and alternate fuel cycles are discussed in detail; finally, the direction of the ORNL studies for the coming year is indicated. (auth)

13762 ASTRON PLASMA PARAMETERS CONFINED IN THE CLOSED MAGNETIC WELL OF A PROTON E-LAYER. Christofilos, N. C. (Univ. of California, Livermore). pp 1.36-43 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A relativistic proton E-layer of energy of 1 GeV is formed in a 32 kG field. The outer radius of the E-layer is approximately 350 cm and its length 500 cm. The combination of the external magnetic field and the field of the proton E-layer form a closed pattern of magnetic lines known as "closed magnetic well" within which plasma is confined. The plasma radius is 250 cm and its length approximately 360 cm. Coulomb interactions of the relativistic protons with the confined plasma can heat the plasma up to a temperature of 10 keV even if the plasma lifetime is limited by anomalous diffusion to approximately 100 Bohm lifetimes. Under the assumption that the energy of the 3.5 MeV α-particles produced by D-T fusion reactions is transferred to the plasma it is possible to sustain a plasma of a temperature of 20 keV and

density of 10^{15} ions/cm^3. The total thermal power yield is approximately 12,000 MW. The plasma diffuses through both ends of the plasma confinement region through the first open magnetic lines. The estimated power required to sustain the E-layer is approximately 600 MW of relativistic protons. It is proposed to accelerate the protons in an electron ring accelerator. Electrons of several hundred MeV are injected in static magnetic field to form an electron ring which subsequently is compressed by properly shaped static magnetic field to a very small diameter. The electron current in the ring is of the order of 50,000 A and its electrostatic field of the order of 6 MeV/cm^3. Subsequently hydrogen ions are trapped. Thereafter the ring is axially accelerated in a decreasing magnetic field carrying the trapped ions which are accelerated to 2 GeV per charge. The ions are trapped in the E-layer by dissociation. Approximately 500 MW of the energy required to sustain the E-layer is trapped in the system. The net electric power produced, assuming a 50% efficiency of the power generation plant, is approximately 50,000 MW. (auth)

13763 GAS COOLING FOR FUSION REACTOR BLANKETS. **Melese-d'Hospital, G.; Hopkins, G. R. (Gulf General Atomic Inc., San Diego, CA). pp 1.65-71 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).**

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The high-energy neutrons generated by the D-T fusion reaction would be absorbed in a blanket consisting of moderator material (say graphite) and lithium for tritium breeding. Energy deposition rates are projected as about 100 w/cm^2 on the vacuum wall surrounding the plasma; energy generation ranges from 100 w/cm^3 to a few w/cm^3 in the blanket. Molten lithium and molten lithium salts which have been frequently proposed as coolants have drawbacks such as interaction with magnetic fields, gamma ray generation, and handling problems. In view of the large experience in gas cooling around the world for advanced fission reactors, it is proposed to use helium to cool the blanket of fusion reactors, and perhaps also the vacuum wall. Either direct gas turbine cycles, or indirect cycles with a gas-to-steam heat exchanger, could be used for electrical power production. (auth)

13764 HIGH-VOLTAGE TEST OF A LARGE CRYOGENIC COIL FOR MAGNETIC ENERGY STORAGE SYSTEM. **Lady, E. R.; Call, D. L. (Los Alamos Scientific Lab., NM). pp 1.77-9 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).**

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The 1-MJ aluminum coil designed and fabricated by NBS, Boulder, Colo., was tested at the Los Alamos Scientific Laboratory while warm, immersed in liquid nitrogen, and immersed in liquid hydrogen. The coil was energized by a 10-kV, 100-kJ capacitor bank, which was crowbarred at the first current maximum. The coil, cryogenic system, and charging network are described. Test results are included. This work demonstrates the feasibility of using a pulsed magnetic energy storage coil immersed in liquid hydrogen. (auth)

13765 MAGNETS FOR OPEN-ENDED FUSION REACTORS. **Moir, R. W.; Taylor, C. E. (Univ. of California, Livermore). pp 1.80-9 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).**

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Open-ended fusion reactors will require magnetic fields with unique shapes, large sizes, and high intensity. These requirements will place stringent demands on magnet materials. In particular, the technical and economic aspects of superconductors are examined. The nearly spherical "Yin-Yang" configuration has the lowest cost of the cases examined. Cryogenic aluminum is competitive with superconductors and should be examined further. Cost estimates and conceptual coil designs are presented. (auth)

13766 THERMONUCLEAR REACTORS AND ELECTRIC POWER GENERATION: A SURVEY. **Myers, Blake (Univ. of California, Livermore). pp 1.95-103 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).**

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A survey is given of a number of aspects of electric power generation in the future with the advent of the thermonuclear reactor. The literature is reviewed and comments are made on power demand growth, fuel resources and the fission breeder inventory crisis, power system economics, hybrid reactors and radiological hazards and safety of reactors. Some assessments are given to the questions of timing and costs for thermonuclear power. (auth)

13767 TECHNOLOGICAL PROBLEMS ANTICIPATED IN THE APPLICATION OF FUSION REACTORS TO SPACE PROPULSION AND POWER GENERATION. **Roth, J. R.; Rayle, W. D.; Reinmann, J. J. (Lewis Research Center, Cleveland). pp 2.36-43 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).**

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Mission and system studies have shown that fusion reactors potentially may be the most attractive energy source for space power and propulsion systems. The methods by which fusion reactors may be applied to space missions are discussed. The problems posed by conversion of the thermal energy of the reacting plasma to electrical power and/or an exhaust jet are considered. Conceptual approaches to space applications are described, and their implications for research and development in the 1970's are reviewed. Recent analytical and experimental studies conducted at the NASA Lewis Research Center are reviewed, and their significance for the future direction of space-related fusion research is discussed. (auth)

13768 JFT-II PLANT: JAERI NUCLEAR FUSION REACTOR. **Itoh, S.; Ota, M.; Funabashi, A. (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 18: No. 5, 38-44(May 1972). (In Japanese).**

An outline of the Japan Fusion Torus (JFT)-II is given. The purposes of the present torus are to check proportionality relations of temperature and to investigate physical problems in the core of fusion reactors. Radius of the torus is 90 cm, and that of the plasma is 25 cm. The toroidal magnetic field is 10 kG. A dynamic limiter which can be removed at high speed is equipped. Control of plasma current and elimination of inhomogeneous field are possible. A vacuum chamber of the torus is made of 0.6 mm thick bellows and forms a one-turn circuit around the main magnetic field. The toroidal coil is composed of 16 sections, and maximum field intensity is 15 kG. A dc generator is used as a power source for the toroidal coil and produces a 10-kG field. Expected values of plasma parameters by using the present apparatus are shown in a table. The expected value of the plasma current is 175 kA for q = 2, and 115 kA for q = 3. (Japan)

13769 TOKAMAK APPARATUS AT JAERI. **Itoh, S.; Hunahashi, A. (Japan Atomic Energy Research Inst., Tokai). At. Jap.; 16: No. 4, 8-15(Apr 1972).**

The Tokamak-type apparatus (JFT-2) at Japan Atomic Energy Research Institute (JAERI) is described. In designing the JFT-2 apparatus, values of ion temperature and energy confinement time were estimated according to scaling laws. The minor radius should be as big as possible. Plasma current duration time was taken to be nearly equal to the expected energy confinement time. The value of vertical magnetic field can be adjusted during the initial stage of plasma formation. A dynamic limiter was prepared. The final design is shown. Main components explained are toroidal magnetic field, the vertical magnetic field, a liner and the limiters, a shell, boxes for observation, a vacuum system, a current transformer, and capacitor banks in primary circuit, and diagnostic methods are listed. Main fundamental dimensions of the JFT-2 and expected plasma parameters are summarized in a table. A preliminary experiment was performed. Plasma current up to 60 KA was obtained. (Japan)

13770 DEVICE FOR THE CONTROLLED THERMONUCLEAR FUSION OF LIGHT ATOMIC NUCLEI. **Duerr, W. German Patent 2,062,837. 3 Aug 1972. (In German).**

The device consists basically of a hollow sphere of insulating material (like quartz) surrounded by a metallic shield. The injected deuterium ions are excited to an ordered motion by eddy currents of an appropriate frequency applied to the metallic shields. The regular motion towards the center of the sphere is sufficient to achieve nuclear fusion; the fusion is controlled by admitting or reducing the working gas. (GF)

13771 INDUCTIVE ENERGY-STORAGE DEVICE. **Marx, E.; Koch, W. (to Kernforschungsanlage). German Patent 1,488,941. 4 May 1972. (In German).**

For physical property investigations of plasmas, an electric circuit was designed which consists basically of two inductivities for storage, switches and breakers connected to a power supply. The inductivities are charged in a series connection, whereas the breaking circuit can be discharged in a parallel connection. (GF)

13772 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, NO. 10, 1972. Bibliography, Author Index, Subject Index, Appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 51p.

This listing contains 265 references on various aspects of plasma physics and fusion reactor research. (MOW)

Wave Phenomena

13773 (AD-746467) STRUCTURE OF A COLLISIONLESS TURBULENT SHOCK WAVE IN PLASMAS. Ahmed, M. H. (Case-Western Univ., Cleveland, Ohio). Jun 1972. Contract N00014-67-A-0404-0007. 155p. NTIS.

A perpendicular collisionless shock wave in a high-beta infinite plasma is considered. The effects of the inhomogeneity of the shock front are analyzed. It was found that the ions are heated up and that the resonant particles see a larger component of the electric field in the direction of the inhomogeneity. From the linear stability it was found that the fastest-growing unstable modes inside the shock front are the beam-cyclotron and pure cyclotron modes. The effects of high beta values on these instabilities were investigated. A new theory was developed to handle the nonlinear evolution of unstable modes. Equations governing the structure of the shock front valid for low as well as high Mach numbers were derived. (auth)

13774 (AD-747852) AMPLITUDE SATURATION OF DRIFT WAVES IN A Q-MACHINE. Kraybill, D. M. (Illinois Univ., Urbana. Coordinated Science Lab.). Jul 1972. Contract DAAB07-67-C-0199. 169p. (UILU-ENG-72-2235). NTIS.

The linear and nonlinear properties of the density-gradient-driven drift-wave instability are studied in a single-ended Q machine in which the drift waves occur at a radius far from the origin ($-r/n\ dn/dr \gg 1$) due to the particular density gradient resulting from an aperture limiter. The drift wave is observed under both collisionless and collision-dominated conditons. Agreement is noted in many respects with the predictions of slab-model calculations, but effects are observed that indicate that the nonuniform radial electric field, which also occurs near the aperture radius, cannot be neglected in an accurate theory. The collisionless drift wave is observed at densities from 9×10^3 to $10^9/cm^3$. The spectral properties, spatial distribution, and stability properties are measured and compared with the predictions of linear theory. Observations of mode–mode coupling effects between drift-wave modes and between the drift wave and another low-frequency instability are described. (auth)

13775 (CEA-CONF-1895) THEORETICAL AND EXPERIMENTAL STUDY OF THE HF CURRENT ASSOCIATED WITH A PLASMA WAVE. Gervais, F.; Guillemot, M.; Olivain, J.; Quemeneur, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 3p. (CONF-720957-1). Dep. NTIS (U. S. Sales Only).

From Conference on gas discharges; London, England (11 Sep 1972).

A plasma wave oscillation is excited by an hf source located at $z = 0$ and propagated along a plasma column. The perturbed electron current associated with the oscillation is derived by means of the linearized Vlasov equation, and its instantaneous value is measured by means of an electrostatic energy analyzer. (auth)

13776 (CEA-R-4375) STOCHASTIC KINETIC THEORY OF THE INTERACTION OF AN ELECTRON PLASMA WITH AN INTENSE ELECTROMAGNETIC WAVE. Di Bona, G.; Masselot, C. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Dec 1972. 83p. (In French). Dep. NTIS (U. S. Sales Only).

A survey of density and temperature diagrams for some experiments on laser interaction with matter allows location of the range of these plasmas. The assumptions of the model allow one to carry out a theory that can be applied generally to the interaction of a strong electromagnetic field with a classical, nonquantum and nonrelativistic plasma, and particularly to laser–matter interactions. A small dimensionless expansion parameter is introduced that takes into account the strong interactions. This kind of interaction is studied by means of a stochastic method arising from Stratonovich. A hierarchy of equations is obtained which can be broken by expanding probability functions with respect to the above-mentioned parameter and by using cluster expansion for correlation functions. Thus, to first order, a set of two kinetic equations governing the system is obtained. The solution of this set of equations leads to the computation of the friction and diffusion terms that appear in the evolution equation for the one-particle distribution function governing the system to first order. This evolution equation turns into a Lenard–Balescu equation when the external field is taken equal to zero. (auth)

13777 (CONF-720705-6) WAVE GENERATION IN THE ST TOKAMAK NEAR THE ION CYCLOTRON FREQUENCY AND ITS SECOND HARMONIC. Hosea, J. C.; Hooke, W. M. (Princenton Univ., N. J. Plasma Physics Lab.). 1972. 3p. Dep. NTIS.

From first topical conference on RF plasma heating; Lubbock, TX (6 Jul 1972).

Wave generation in the vicinity of the ion cyclotron frequency and its second harmonic is currently under investigation in the ST tokamak. A novel coil exhibits considerable loading and magnetic probes indicate that the loading attributable to the plasma is due to waves propagating along the plasma torus. (auth)

13778 ENHANCED ENERGY TRANSFER TO A CYLINDRICAL PLASMA BY AN ALFVEN WAVE. Lancaster, D. B. Jr. Lubbock, TX; Texas Tech Univ. (1972). 79p. University Microfilms Order No. 72-32,053.

Thesis.

Enhanced transfer of 3.8-MHz energy to a partially ionized gaseous plasma, with densities up to about 10^{21} m^{-3}, was observed for particular combinations of filling pressures and bias magnetic fields. Both hydrogen and deuterium gases were used. A 0.06 μf capacitor, initially charged to 15 kV, discharges into a 20-cm-long, 7-cm-diameter, one-turn solenoid surrounding the plasma. In addition to the large energy transfer from the theta-discharge capacitor at the critical condition, a corresponding increase in the ringing frequency of the R–L–C circuit is observed. For slightly larger bias fields the ringing frequency abruptly decreases. As the field increases further, the damping of the voltage waveform first increases and then decreases. For these bias fields, the ringing frequency is nearly constant. These experimental observations are found to agree quite well with those expected for an Alfvén wave propagating perpendicularly to the bias magnetic field in a partially ionized plasma. Theoretical investigations include solving the momentum transport equations consistent with Maxwell's equations for a three-species plasma for the time-varying, axial magnetic flux density. The flux density is then used to formulate a complex, magnetic-field-dependent inductance for the plasma. This inductance is shown to account for the observed capacitor voltage waveform over a wide range of experimental parameters. The energy-transfer mechanism could be of possible interest in controlled thermonuclear fusion reactors if the static magnetic field is increased to 8 T and the plasma radius is increased to 100 cm. For these parameters the exciting frequency needs to be increased to about 8 MHz for the enhanced transfer mechanism to occur in a plasma with a density of 10^{21} m^{-3}. (Diss. Abstr. Int., B)

13779 PROPAGATION OF ELECTROMAGNETIC WAVES IN MEDIA WHICH VARY SLOWLY WITH POSITION AND TIME. Fante, R. L. (Air Force Cambridge Research Labs., Bedford, MA). Radio Sci.; 7: No. 12, 1153-62(Dec 1972).

WKB methods are used to consider the propagation of electromagnetic waves in isotropic lossless media that vary slowly with both position and time. It is found that in such media the meaning of various quantities, such as the group velocity, must be reinterpreted. The theory is applied to study propagation in space–time, varying dielectrics, and plasmas. (auth)

13780 NET-FIELD POLARIZATION IN A MAGNETICALLY BIASED PLASMA. Rusch, W. V. T. (Univ. of Southern California, Los Angeles); Stelzried, C. T. Radio Sci.; 7: No. 12, 1131-41(Dec 1972).

The net-field polarization of a plane wave propagating in a magnetically biased cold plasma has been treated in a systematic fashion. Under quasi-longitudinal conditions the polarization transformations are particularly simple and as such have been treated in the literature. However, under more general conditions the polarization transformations are relatively complex. The axial ratio, tilt angle, rotation rate, and polarization sense all become functions of the initial conditions and the constants of the medium. Under quasi-longitudinal conditions the polarization ellipse rocks between two extremes, while the axial ratio also changes periodically between a minimum and a maximum value (Cotton–Mouton effect). The wide variety of polarization transformations available suggests the usefulness of slabs of magnetically biased plasma to synthesize microwave polarizers and depolarizers. The theory of net-field polarization when applied to data obtained during the 1968 solar occultation of Pioneer 6 verified that the usual quasi-longitudinal approximation (Faraday rotation) is adequate to describe S-band polarization in the solar corona. (auth)

13781 ELECTROMAGNETIC WAVE PROPAGATION IN PLASMA WITH A SHEARED MAGNETIC FIELD. Suvorov, E. V.

(Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 9, 1320-4(1972). (In Russian).

A discussion was given of the polarization plane rotation when a linearly polarized wave is propagating in plasma with a sheared magnetic field. The geometrical optics solutions determining the wave propagation in such a medium with smooth inhomogeneity are found. (tr-auth)

13782 COMPRESSION OF THE WAVE POWER DENSITY BY MEANS OF A TIME-VARYING MEDIUM. Pozwolski, A. E. J. Phys. Soc. Jap.; 34: No. 1, 193-5(Jan 1973).

Propagation of waves in a medium homogeneous in space but with time-varying properties is considered. It is shown that this can result in compression of a signal and a gain in power. The signal becomes also frequency modulated. For nondispersive waves, such as acoustic waves, there is an increase in frequency, whereas for transverse electromagnetic waves the frequency is lowered for the particular scheme of propagation considered. (auth)

13783 SATELLITE GENERATION OF ELECTRON PLASMA WAVES FROM LOW-FREQUENCY OSCILLATIONS IN PLASMAS. Ohkubo, K.; Tanaka, S. (Kyoto Univ.). J. Phys. Soc. Jap.; 34: No. 1, 201-8(Jan 1973).

Experiments demonstrating that the satellite generation of a stable electrostatic wave in the presence of an electron density oscillation in a bounded plasma and that the satellite generation of the unstable plasma wave in a modulated electron beam–plasma system are described. The spatially periodic energy transfer among the satellite modes and the primary mode is observed, which results in an enhanced damping of the stable primary mode in the former case and a decrease in a growth rate of the unstable primary mode in the latter. These results are compared with the theoretical prediction derived by expanding the wave number in terms of fluctuating plasma parameters as well as by using the coupled mode equations. (auth)

13784 ELECTROMAGNETIC WAVE EXCITATION IN PLASMA BY A PHASED-OSCILLATOR BEAM. Kitsenko, A. B.; Panchenko, V. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 9, 1325-40 (1972). (In Russian).

The interaction of a phased-oscillator beam with a cold plasma in the constant magnetic field is investigated. The beam modulation over the momentum azimuth angle is shown to lead to the appearance of parametric instabilities if for the natural plasma frequencies ω_α and ω_β the decay type condition $|\omega_\alpha| + |\omega_\beta| = n\,\omega_B$ (n = 2, 3, . . .) is valid and phase velocities of waves α and β have opposite direction. The parametric excitation takes place under the conditions when the density and beam velocity modulation is absent. At the interaction of the oscillation branches when $|\omega_\alpha| = |\omega_\beta|$, the parametric excitation takes place for the integer and half-integer harmonics of the beam particle gyrofrequency. If the angle between the direction of the magnetic field and the wave vector is equal to $\pi/2$, then the half-integer harmonics are not excited. The growth rates of the oscillations at the parametric instability are proportional to the depth of modulation Im $\omega \sim n_b/n_p\,\omega_\alpha$ (n_b and n_p are the beam and plasma densities, respectively). Under the conditions of combined beam-parametric resonance the growth rates of the oscillations are of the order of $(n_b/n_p)^{1/3}\,\omega_\alpha$. The presence of the parametric resonance influences essentially the growth rates at the beam resonance. (tr-auth)

13785 TEMPORAL GROWTH OF A PLASMA OSCILLATION. Itakura, A.; Tsuru, T.; Nakamura, Y.; Kojima, S. (Tokyo Univ. of Education). J. Phys. Soc. Jap.; 34: No. 1, 176-80(Jan 1973).

A plasma oscillation excited due to a beam–plasma interaction forms sometimes a standing wave between electrodes. The oscillation is suppressed by modulating the beam with a high-frequency signal as previously reported. When the modulation is removed, the oscillation begins to grow. From displays of this phenomenon on an oscilloscope, the growth rate is directly observed. Indirect method based on a van der Pol equation is also tried for the same oscillation. The results are compared with the theory. (auth)

13786 SCATTERING OF MICROWAVES BY A STRATIFIED OVERDENSE PLASMA AT HIGH COLLISION FREQUENCIES. Klein, M. M. (Air Force Cambridge Research Labs., Bedford, MA). J. Appl. Phys.; 44: No. 1, 91-5(Jan 1973).

A study was conducted, for several electron-density distributions, of the reflection of electromagnetic waves from stratified overdense plasmas in which the rate of collision frequency to incident frequency is large and the transmission negligible. With positive power profiles where the density changes slowly near the turning point, the reflection coefficient is small, whereas for inverse power profiles where the density gradient is large near the turning point, the reflection is large. In the case of a symmetric type of profile where the maximum density is finite, the results are dependent upon profile type. In an inverse profile type, the reflection is fairly sensitive to maximum density, decreasing with it. With a Gaussian distribution, reflection increases slowly with maximum density. (auth)

13787 DISPERSION RELATIONS OF BOUNDED INHOMOGENEOUS ANISOTROPIC PLASMAS. de Santis, P. (Univ., Naples); Franceschetti, G. J. Appl. Phys.; 44: No. 1, 513-15(Jan 1973).

The dispersion characteristics of electrostatic modes in a longitudinally magnetized parallel-plate waveguide completely filled with a transversely inhomogeneous cold collisionless electron plasma, obtained by Poularikas and Perl, are reexamined in the light of some previously published results. (auth)

13788 MULTIPLE SOLITON PRODUCTION AND THE KORTEWEG–DE VRIES EQUATION. Hershkowitz, Noah; Romesser, Thomas; Montgomery, David (Univ. of Iowa, Iowa City). Phys. Rev. Lett.; 29: No. 24, 1586-9(11 Dec 1972).

Compressive square-wave pulses are launched in a double-plasma device. Their evolution is interpreted according to the Korteweg–de Vries description of Washimi and Taniuti. Square-wave pulses are an excitation for which an explicit solution of the Schroedinger equation permits an analytical prediction of the number and amplitude of emergent solitons. Bursts of energetic particles (pseudowaves) appear above excitation voltages greater than an electron thermal energy, and may be mistaken for solitons. (auth)

13789 HIGH-FREQUENCY POTENTIAL INFLUENCE ON FAST TRANSVERSE MAGNETIC WAVES ALONG A PLASMA LAYER. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 203-9(Feb 1972). (In Russian).

The propagation of transverse-magnetic waves along a plane-parallel plasma layer bounded by two ideal conducting plates is considered, taking into account the high-frequency potential of the wave. Expressions for fields, plasma density distribution, and dispersion equations are obtained. It is shown that the high-frequency potential can cause penetration of the electric field into plasma, something not observed in the linear approximation because of the skin effect. (auth)

13790 EFFECT OF DENSITY FLUCTUATIONS ON SCATTERING OF ELECTROMAGNETIC WAVES IN DENSE TURBULENT PLASMA. Sharma, S. C.; Verma, J. S. (Birla Inst. of Tech. and Science, Pilani, India). Indian J. Pure Appl. Phys.; 10: No. 5, 335-9(May 1972).

A simple expression for the scattering factor in turbulent plasma is derived. The expression that shows the effect of density fluctuations is derived on the basis of the density fluctuations predicted by the linearized hydrodynamic equations. These results are generalized with suitable choice of density and temperature of the plasma following the approach of L. Landau and G. Placzek (Phys. Z. Sowjdn., 5: 172(1934)). Values of the scattering factor calculated for different situations of the plasma are reported. It is concluded that further refinement of the expression is possible with the availability of dependable correlation functions. (auth)

13791 DISCUSSION OF RADIATIVE-TRANSFER METHODS APPLIED TO ELECTROMAGNETIC REFLECTION FROM TURBULENT PLASMA. de Wolf, D. A. (RCA Labs., Princeton, NJ). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-20: No. 6, 805-7(Nov 1972).

The reflected energy flux of electromagnetic waves incident upon an underdense turbulent plasma recently was extended beyond the weak-scattering Born approximation by two different methods. One approach is based upon summing cumulative small-angle propagation effects between successive large-angle scatterings. A heuristic application of radiative-transfer methods under the same approximations and conditions yields a backscatter cross section that differs by a factor of up to one-half at given plasma thickness. It is shown that the cross section can be made to agree with that of the selective-summation approach by including a class of contributions that appears to have been omitted in the radiative-transfer approach. (auth)

13792 NONLINEAR LONGITUDINAL OSCILLATIONS OF RELATIVISTIC PLASMA. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Establishment, Cairo). Z. Phys.; 257: No. 3, 224-34(1972).

An investigation was made of nonlinear forced longitudinal oscillations in a relativistic plasma. It was demonstrated that: (a) the nonlinear terms $(v\nabla)p$ arising in the equations of motion do not restrict the electron oscillation amplitude increase in the region of plasma resonance; (b) the nonlinear terms due to the

relativistic nature of oscillations, firstly, limit the oscillation amplitude in the resonance region and, secondly, lead to the development of a parametric instability. The harmonic, sub- and ultraharmonic oscillations turned out to be unstable. The conditions for the instability, as well as expressions for the growth rates of unstable oscillations, were obtained. (auth)

13793 DISPERSION PROPERTIES OF ION-ACOUSTIC WAVES IN A CYLINDRICAL PLASMA COLUMN. Levitskii, S. M.; Filonenko, E. G. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 131-3(Jan 1972). (In Russian).

The dispersion properties of ion-acoustic waves were investigated in the positive column of a gas discharge. The measured dispersion characteristics of the ion-acoustic wave consisted of three branches, two of which were identified with two radial modes of the ion-acoustic wave, and the third branch of a surface type that possessed negative dispersion. The radial distribution of the longitudinal component of the electric field of an ion-acoustic wave was also measured. (tr-auth)

13794 PROPAGATION OF ELECTROMAGNETIC WAVES IN A RAREFIED PLASMA PLACED IN AN ALTERNATING MAGNETIC FIELD. Zaiko, Yu. N.; Kats, L. I.; Kireev, N. N.; Smolyanskii, S. A. (Inst. of Mechanics and Physics, Saratov, USSR). High Temp. (USSR) (Engl. Transl.); 10: No. 2, 206-214(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 232-242 (1972).

The process of the propagation of an electromagnetic wave in a plasma situated in an alternating magnetic field is considered for an arbitrary mutual orientation of the intensity vectors of the constant and alternating magnetic fields and the wave vector k of the electromagnetic wave. It is shown that the presence of an alternating magnetic field leads to the appearance of additional resonant frequencies and frequency-cutoff regions, and likewise to the possibility of "bleaching" fairly large plasma layers. (auth)

13795 CHARACTER OF ACOUSTIC DISPERSION IN PLASMA. Sinkevich, O. A. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 2, 215-218(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 243-247 (1972).

It is shown that in addition to the usual dispersion of phase velocity caused by the effects of viscosity and heat conductivity, which depends on the frequency of vibrations, there exists in plasma an addition to phase velocity that does not depend on frequency. This addition depends on the density of the electric current and reflects the influence of Joule heating. In the presence of a magnetic field, additional dispersion is manifested that is most substantial at low frequencies. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 12303, 12307, 12993, 12997, 13852, and 13993.

13796 (AD–890434) X-RAY CROSS SECTION COMPILATION FROM 0.1 keV TO 1 MeV. DISCUSSION AND RESULTS. VOLUME I. REVISION I. Final Report, April 28, 1970–July 31, 1971. Veigele, W. J.; Briggs, E.; Bates, L.; Henry, E. M.; Bracewell, B. (Kaman Sciences Corp., Colorado Springs, Colo.). 31 Jul 1971. Contract DASA01-70-C-0126. 229p. (KN–71-431(R)(Vol.1)); DNA–2433-F(Vol.1)). NTIS.

Experimental x-ray attenuation cross sections for 94 elements between 0.1 keV and 1 MeV were obtained for the period from 1920 through 1970. Exact photoelectric absorption values also were calculated for hydrogen. Scattering cross sections were calculated by relativistic SCF methods. These were subtracted from total attenuation data, and the resulting photoelectric and measured photoelectric absorption cross sections from 1 keV to 1 MeV were fit by a least-squares procedure to obtain best values. Interpolations were made for elements and energy ranges for which there were no experimental data. From 0.1 keV to between 1 keV and 10 keV non-relativistic, self-consistent, independent electron theory was used to calculate photoelectric absorption cross sections. Scattering values were added to all photoelectric cross sections to obtain a best set of attenuation cross sections (auth)

13797 (COO–3243-1, pp 8-119) RADIOLOGICAL PHYSICS. 1 Jul 1972.

In Annual report on research project.

Progress is reported on the following: measurements of dose profile both in cross section and depth for 278 MeV/amu nitrogen and neon ions in 30 × 30 cm phantoms of lucite sheets and water in lucite tanks; effects of dose nonuniformities when irradiating material near the Bragg peak of the ions from the Princeton Particle Accelerator; depth-dose curves for 3.9-GeV nitrogen ions and 5.7-GeV neon ions; specialized dosimetry at the Radiological Research Accelerator Facility (RARAF) for irradiations of Vicia faba, Drosophila melanogaster, Tradescantia, and rats; event distribution data for entire range of monoenergetic neutrons at RARAF; event distribution data of monoenergetic photons from fluorescent x-ray generator now in use; mean energy deposited in uniformly irradiated microscopic spheres from 1.7- to 4.0-MeV protons; comparison of walled and wall-less counters in microdosimetry of 287-MeV/amu nitrogen ions; microdosimetric distributions for californium-252 in air; operation and development of the RARAF; and development of comprehensive dosimetry instrumentation (miniature electrometer amplifiers; capacitor ion chamber, x-ray chamber, and ^{137}Cs chamber intercomparisons; and the mirror protractor arrangement). (LMT)

13798 (LA-DC–72-1386) VISUALIZATION OF PION STOPPING REGION. Dean, P. N. (Los Alamos Scientific Lab., N. Mex.). [nd]. 3p. (CONF-721121–1). Dep. NTIS.

From National meeting on applications of optical instruments in medicine; Chicago, IL (29 Nov 1972).

Negative pi mesons were proposed as a modality for tumor therapy. They have many possible advantages over other modalities. One of these is the possibility of in situ monitoring of the treatment volume. Five methods of doing this have been proposed. Experiments to test three of the methods involving nuclear gamma rays, the production of positron emitters, and detection of mesic x rays have been performed. The results of these experiments are reported. (auth)

13799 ANGULAR DISTRIBUTIONS OF ELECTRONS WITH INITIAL ENERGIES OF 12 TO 25 MeV BY BARRIERS OF TUNGSTEN, CADMIUM, AND COPPER. Kovalev, V. P.; Kharin, V. P.; Gordeev, V. V.; Isaev, V. I. At. Energ. (USSR); 33: No. 5, 932-4 (Nov 1972). (In Russian).

The angular distributions of 12- to 25-MeV electrons upon penetration of foils of various thicknesses were studied. The beam of electrons from a linear accelerator had a diameter of 6 mm where it struck the foils, which were made of W, Cd, or Cu. The ionization chamber was arranged so as to monitor both electrons penetrating the foils, and the bremsstrahlung from the scattering foil. (K.S.W.)

13800 EXPERIMENTAL ASPECTS OF X-RAY SCATTERING FROM ELECTRONS IN MATTER. Platzman, P. M. (Bell Telephone Labs., Murray Hill, NJ). Comments Solid State Phys.; 4: No. 4, 101-10(May 1972).

Experimental measurements of the Compton effect are discussed for simple atoms such as helium gas, more complicated molecules such as gaseous hydrogen, and metals (Na and Li), and Compton spectra are reproduced. The Compton spectrum for a free homogeneous electron gas is also shown. The fact that the Compton or inelastic x-ray spectrum contains useful information has been demonstrated and exploited by several groups of workers during the past few years, but much more study remains to be done. Increased resolution will permit study in detail of the nature of electronic wavefunctions in the neighborhood of reasonably high temperature electronic transitions; higher energy x-rays will enable the examination of higher Z materials, and this will enable examination of the Fermi surface of alloys, etc.; relativistic coupling of x-rays to spin will lead to the probing of magnetic systems by x-rays; and more complicated molecules, including organic materials, need examination, and information gained complementary to that obtained utilizing Bragg reflection. (UK)

13801 COMPUTATION OF PION DEPTH-DOSE CURVES IN WATER AND COMPARISON WITH EXPERIMENT. Turner, J. E.; Dutrannois, J.; Wright, H. A.; (and others) (Oak Ridge National Lab., TN). Radiat. Res.; 52: No. 2, 229-46(Nov 1972).

A Monte Carlo program was written for calculating absorbed dose as a function of position in a water target irradiated by beams of pions (π^+ and π^-). The incident pions can have an arbitrary energy spectrum, at present limited to 125 MeV, this energy including most beams that have been used in radiobiological experiments. The presence of muons and electrons, which contaminate pion beams in practice, is also included. The incident particles may enter the target at any point and with any direction of travel. Calculations can thus be made for nonparallel, nonuniform beams. The size of cylindrical volumes in the target over which the absorbed energy is averaged can be varied to simulate the use of detectors of various dimensions. The calculations include pion–nucleus interactions, multiple coulomb scattering, pion and muon decay at rest, as well as the transport and further interactions of secondary protons and neutrons. Good agreement is obtained between calculated and measured depth–dose curves with π^+ and π^- beams from the 600 MeV synchro-cyclotron at CERN. The program will be used to study various factors that affect the dose and LET patterns that can be obtained with realistic pion beams. (auth)

13802 MONTE CARLO CALCULATIONS OF THE DOSE INDUCED BY CHARGED PIONS AND COMPARISON WITH EXPERIMENT. Armstrong, T. W.; Chandler, K. C. (Oak Ridge National Lab., TN). Radiat. Res.; 52: No. 2, 247-62 (Nov 1972).

A calculational method that utilizes Monte Carlo techniques in conjunction with the intranuclear-cascade-evaporation model for treating nuclear interactions is applied to study the dose induced in matter by charged pions. To test the validity of the calculational method for pion dose calculations, calculated results are compared with experimental data for the absorbed dose induced in water phantoms by a π^- beam of mean momentum 175 MeV/c and by π^- and π^+ beams of mean momentum 150 MeV/c. The calculated and experimental results are in good general agreement, but the comparisons are not completely definitive because precise descriptions of the incident beams used in the experiments are not available. The calculations indicate the importance of secondary particles in determining the spatial dependence of the absorbed dose and dose equivalent. Information on the spatial dependence of the neutron current produced by the 175-MeV/c π^- beam is also calculated. (auth)

13803 INVARIANT IMBEDDING AND RADIATION DOSIMETRY. III. INTEGRAL RECURRENCE RELATIONS FOR FINITE ORDER X AND Y FUNCTIONS. Bellman, R. (Univ. of Southern California, Los Angeles); Ueno, S.; Vasudevan, R. Math. Biosci.; 15: No. 3/4, 195-203(Dec 1972).

Numerical evaluation of X and Y functions (which are related to the transmitted and reflected flux of radiation from a target slab) are relevant to computing the dosage received by irradiated bodies in problems met with in radiation dosimetry. The finite-order X and Y functions are studied, and linear recurrence relations are obtained that make computation easy. (auth)

13804 EFFECTIVE ATOMIC NUMBERS FOR GAMMA-RAY INTERACTIONS IN ALLOYS. Arun, R.; Siddappa, K.; Ramarao, J.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian Mining Eng. J.; 10: No. 9, 9-13(1971).

A study of the effective atomic numbers for gamma ray interactions in alloys revealed that: (i) the number for the partial process remains constant whereas that for the total varies; (ii)

the theoretical expressions for the estimation of the numbers for partial, as well as for total, give the corresponding numbers with a few percent accuracy; and (iii) the corresponding nearest equivalent atomic number element can be used, if necessary, in place of an alloy to get the same effect, for partial as well as for total interactions. (Indian Sci. Abstr.)

13805 MEASUREMENT OF SCATTERED GAMMA RAYS. 2. ^{170}Tm GAMMA RAYS SCATTERED IN IRON AND ALUMINUM PLATE. Tsujimoto, T.; Katsurayama, K. (Kyoto Univ., Osaka). Hihakai Kensa; 21: No. 9, 521-7(Sep 1972). (In Japanese).

The energy spectrum and dose of gamma radiation scattered in iron and aluminum plate were measured. The gamma energy spectrum of a ^{170}Tm source is a continuous bremsstrahlung curve up to 1 MeV, with the peak at 84, keV. The measuring system consisted of a scintillation detector (25 mmϕ × 2mml NaI (Tl) crystal) with a 400-channel pulse-height analyzer and the log amplifier. The response function of the detector was experimentally determined from the spectrum of several monochromatic gamma rays. The doses of scattered and direct gamma radiation were obtained from the unfolded spectra. The main results are as follows: the directly transmitted gamma spectrum was continuous up to 1 MeV, but the scattered gamma spectrum was less than 0.4 MeV and then the maximum energy intensity was ~0.1 MeV. The dose obtained from this method was compared with that obtained through ionization-chamber measurement and found more correct. (auth)

13806 TRANSITION-MATRIX APPROACH TO ELECTRON SCATTERING FROM AMORPHOUS MATERIALS. Boyce, J. F.; Burge, R. E.; McCloughrey, J. K. (Queen Elizabeth Coll., London). Phys. Status Solidi (b); 54: No. 2, 491-501(1 Dec 1972).

A formalism is developed to permit the calculation of scattering of high-energy electrons. It is shown to reproduce the usual results of the dynamical theory for scattering from a perfect crystal. For a particular model of a distorted crystal, an explicit closed form is obtained for the correction due to amorphism. (auth)

13807 QUALITY OF RADIATION AND DOSE DISTRIBUTIONS IN CLOSE X-RAY THERAPY. Akatkin, O. A. Med. Radiol.; 17: No. 9, 70-4(Sep 1972). (In Russian).

The dose distributions of long-wave X-ray radiation in a tissue-equivalent medium were measured. In phantom measurements a detector was used with a significant energy dependence. The measurements were carried out with the use of a scintillation spectrometer. (auth)

13808 SPECIFIC ENERGY LOSS OF ^{4}He IONS IN SILICON (AMORPHOUS, POLYCRYSTALLINE, AND SINGLE CRYSTAL). Ziegler, J. F.; Brodsky, M. H. (IBM Watson Research Center, Yorktown Heights, NY). J. Appl. Phys.; 44: No. 1, 188-96(Jan 1973).

The specific energy loss of ^{4}He ions in silicon was determined in the energy range 420 to 2750 keV. Several different methods of determining the specific energy loss were used to check the results. Studies were made of the variation of specific energy loss with silicon density and showed that lower-density amorphous silicon has relatively higher specific energy losses. Studies were also made of the specific energy loss of ^{4}He ions in radiation-damaged, polycrystalline, and single-crystal silicon. The values were then used in a thick-target calculation to generate spectra of ^{4}He backscattering from silicon targets. These calculations were compared to experimental spectra over a range of energies and backscattering angles. All calculations were within 2% of the experimental spectra. The "random" spectrum from a spinning crystal target was compared to thick-target calculations and shown to be useful as a normalizing spectrum with an accuracy of ±5%. (auth)

13809 ANALYSIS OF ENERGY DEPOSITION IN WATER AROUND THE SITE OF CAPTURE OF A NEGATIVE PION BY AN OXYGEN OR CARBON NUCLEUS. Dutrannois, J. R. (European Organization for Nuclear Research, Geneva); Hamm, R. H.; Turner, J. E.; Wright, H. A. Phys. Med. Biol.; 17: No. 6, 765-70 (Nov 1972).

A study was made of the energy deposited in water spheres and cylinders of increasing size around the site at which an oxygen or carbon nucleus captures a stopped negative pion. No great differences were found either between results for O and C or between results for spheres and cylinders. It is pointed out that, as known from the literature, approximately 100 MeV is released as kinetic energy of secondary products after capture, about 60 MeV to neutrons and 40 MeV to charged particles. Most of the neutron energy is transported away from the immediate capture site. Calculations showed that 50% of the charged-particle energy was deposited within a distance of 0.1 cm from the site and 90% within 2 cm. Practically all charged particles with an LET 170 MeV cm^{-1} in water lost their energy within 0.2 cm. The calculations also showed that, on the average, 30 MeV of energy is deposited inside a sphere of 1 cm radius/π^- capture by oxygen and 35 MeV/capture by carbon. (auth)

13810 PROCEEDINGS OF THE HOSPITAL PHYSICISTS' ASSOCIATION ANNUAL CONFERENCE. Phys. Med. Biol.; 17: No. 1, 108-13(Jan 1972).

During a 3-day meeting papers were read on the following subjects and brief abstracts are presented: (1) technical and safety problems of patient monitoring (E.C.G., etc.) in intensive care units; (2) neutron and electron dosimetry in radiobiology and radiotherapy and the differences from photon dosimetry (particular reference is made to the 14-MeV neutron program at Manchester, neutron calorimetry, $FeSO_4$ dosimetry, the use of 2.3-MeV neutrons produced by the decay of ^{252}Ca, and electron dosimetry as applied to the radiotherapeutic use of an M.E.L. SL75 linear accelerator); and (3) the quantitative fate of clinically administered radionuclides, with particular reference to thyroid and kidney measurements. (UK)

13811 DISTRIBUTION OF ABSORBED ENERGY FROM A POINT BETA-SOURCE IN A TISSUE-EQUIVALENT MEDIUM. Bochkarev, V. V.; Radzievskii, G. B.; Timofeev, L. V.; Demyanov, N. A. (Inst. of Biophysics, Moscow). Int. J. Appl. Radiat. Isotop.; 23: No. 11, 493-504(Nov 1972).

The point source functions ψ (r) were determined for beta-radiation with energies in the range 18 keV to 3.5 MeV. The conditions that must be satisfied by the functions ψ(r) are formulated and possible methods of finding these functions are discussed (the Loevinger method and the application of Spencer's theory). In order to determine ψ(r) the values of the function $\psi(r,E_i)$ for an isotropic point source of monoenergetic electrons of energy E_i were found. For $\psi(r,E_i)$ experimental data and the "single dose distribution approximation" (scaling law for dose distributions) were used. The ψ(r) functions for 14 beta sources were obtained by summing the functions $\psi(r,E_i)$ for the narrow energy bands into which the original spectra were divided. The integrals from the calculated functions were compared with the corresponding experimental values, the latter being determined by ionization measurements and good agreement was found. An empirical formula has been found which describes the dose distributions of the isotopes which were studied and its parameters have been evaluated. (auth)

13812 RADIATION EXPOSURE DURING THE BIOSATELLITE 3 PRIMATE FLIGHT. Hewitt, J. E. (Ames Research Center, Moffett Field, Calif.); Schaefer, H. J.; Sullivan, J. J. Health Phys.; 23: No. 4, 461-8(Oct 1972).

The radiation field within the capsule of the Biosatellite III primate flight was monitored at two locations with photoemulsions and TLD sensors. The recorded mission dose of about 300 mrad accumulated in 8.5 days in orbit was trivial as far as acute or chronic radiation injury to the test animal, a Macaca nemestrina monkey. A major part of the mission dose was due to trapped protons encountered in repeated passes through the South Atlantic Anomaly. Because of high QF values applying to low-energy protons and alpha particles, tissue disintegration stars released by galactic primaries constituted a sizeable contribution to the dose equivalent. Exposure to heavy primaries, in terms of absorbed dose representing less than 1% of total dose, represented a dose contribution whose radiobiological significance is essentially unknown. For the target volume of the primate brain, the recorded flux of heavy primaries corresponds to a total track length of about 2000 cm. (auth)

13813 ALBEDO OF γ PHOTONS ON GRAPHITE CYLINDERS. Krasnoshchekov, N. V.; Kuz'menko, A. N.; Pozneev, D. B. This paper was summarized in At. Energ. (USSR); 31: No. 6, 622(Dec 1971) as paper No. 546/6377. (In Russian).

Full copy of this paper is held by TIC.

Monte Carlo calculations were made of the spectral–angular and integrated characteristics of γ photons emitted by ^{203}Hg, ^{137}Cs, and ^{60}Co and backscattered by cylindrical graphite reflectors. Geometries of a mononormal source and an isotropic source of primary radiation placed at the center of the base of the cylinder are examined. The calculations were carried out for the case of cylindrical reflectors of radius r and height d equal to 0.1, 0.2, 0.6, 1.0, and 2.5 free-path lengths of the primary γ photons. The effect of changes in radius on the albedo is most substantial in the case of large-thickness reflectors (≥0.6 mean-free-path lengths). This is manifested in the energy spectra and in the angular distributions of the backscattered photons. Systematic data are presented on the differential numerical current albedo $A(\theta)$ and energy albedo $A_E(\theta)$ as functions of the variables r and d and of the energy of the primary γ-photons. (TSS)

Radiation Source Calibration and Standardization

13814 LOSSES FROM RADIOACTIVE SOLUTIONS WITH STANDARDIZED DISINTEGRATION RATES. Tuck, A. G.; McNair, A. (Radiochemical Centre Ltd., Amersham, Eng.). Int. J. Appl. Radiat. Isotop.; 23: No. 8, 395-6(Aug 1972).

A problem encountered by a radioactivity standards laboratory is that of providing standardized radioactive solutions in containers that are convenient for the user while maintaining their standards integrity. When a radioactive solution having a standardized disintegration rate is used, it is essential that any significant loss of radioactive material from solution that has occurred since the solution was prepared by the standardizing laboratory is due only to radioactive decay. It is not normally difficult to formulate solutions chemically stable in contact with glass surfaces, but problems can arise if the solution is supplied in a vial sealed with materials such as rubber. Solutions of different radionuclides were investigated to determine how serious a problem adsorption of radioactive material from dilute solutions on to closures may be. The vials employed were sealed with latex rubber closures lacquered with an epoxy resin. Results are shown tabulated, and were very variable. With Cs solutions a significant increase in concentration was observed over a period of 6 weeks while the solution was in contact with the closure, presumably explained by loss of vapor around the seal to the atmosphere. Teflon-coated rubber was satisfactory from the point of view of chemical stability, but introduced other difficulties by increasing the rate of evaporation to the atmosphere. It is concluded that accurately standardized solutions should be supplied only in sealed glass ampoules. (UK)

Shielding Calculations and Experiments

Refer also to abstract 13799.

13815 (AD-746870) REANALYSIS OF THE NEUTRON SPECTRUM MEASUREMENTS IN AN IRON BULK ASSEMBLY. Final Report. Cerbone, R. J. (Gulf Radiation Technology, San Diego, Calif.). 9 Oct 1971. Contract DASA01-71-C-0106. 43p. (GULF-RT-A-10859; DNEA-2779-F). NTIS.

A reanalysis was made of neutron spectrum measurements in a 76.2-cm-diameter iron sphere. Comparisons are made with a 296-group ANISN calculation using MAT 1101 and a 49-group 1DF calculation using the Westinghouse Evaluation, ENDF/B 1968. The integral agreement is reasonable above 0.5 MeV, i.e., 10 to 25%; in the keV region the agreement is poorer for both calculations. (auth)

13816 (CEA-R-4376) SHIELD STUDIES: PROPAGATION OF 14 MeV NEUTRONS IN ACCESS BAFFLES AND CIRCULAR CHANNELS. Logre, P.; Bory, P.; Couvert, D.; Drouvin, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1972. 74p. (In French). Dep. NTIS (U. S. Sales Only).

Theoretical calculations on the thickness of shielding and the effectiveness of the access baffles surrounding 14 MeV neutron generators are very complex. In addition, the spectra resulting from multiple interactions are not always very well known, and the determination of the dose rate behind such shields necessitates (other than for simple cases) complicated calculations. Measurements are presented on the baffle systems most frequently used in conjunction with 14-MeV neutron generators (double elbow access baffles; single elbow access baffles; circular channels, with or without elbows traversing a concrete shielding). Different types of detectors were used: a BF_3 counter; a recoil proton proportional counter, which measures the dose absorbed in the first collision in rads; an Anderson and Braun counter measuring the equivalent dose in rem; multisphere equipment and a threshold detector for measuring energy spectra. The results are presented in the form of a table with curves and facilitate various extrapolations. (36 figs., 16 tables) (auth)

13817 (FEI-304) OPTIMIZATION OF THE FORMS OF PROTECTION NEAR SOURCES OF NEUTRON AND GAMMA-IRRADIATION. Petrov, E. E.; Shemetenko, B. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Fiziko-Energeticheskii Institut). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

An expression for the dose function for shielding of arbitrary shape placed near a point source in an infinite scattering medium was obtained from the use of integral characteristics of the penetration of neutron and gamma radiation through matter. The problem of the optimum form for such a shield was solved with the help of this function by the method of variational calculation. Experimental measurements with Po-Be and ^{60}Co sources placed in the optimized shielding were made to test the calculated shielding against neutrons and gamma quanta. (tr-auth)

13818 (RD/B/M-2377) COMPUTERISED INFORMATION FILE. Fraser, A. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1972. 20p. Dep. NTIS (U. S. Sales Only).

A system of filing and accessing reports on shielding topics has been set up. The computer program SHIN is used to generate index cards and carry out searches on the file of record entries. An assessment is made of the value of this system in conjunction with other neighboring information sources. (auth)

13819 INVESTIGATION OF FAST NEUTRON SPECTRA IN IRON AND URANIUM-IRON ASSEMBLIES RESULTING FROM THE INTERACTION OF 14 MeV NEUTRONS. Kabir, S. M.; Cooper, P. N. (Aston Univ., Birmingham, Eng.). J. Nucl. Energy; 26: No. 11, 573-9(Nov 1972).

The neutron spectra inside a cylindrical shield of iron and iron-uranium containing a point source of 14 MeV neutrons were investigated with activation detectors having thresholds in the range 1.4 to 11 MeV. Measured activities were compared with those found from removal-diffusion multigroup calculations using cross-section sets by Yiftah and Sieger (maximum energy 14 MeV) and Abagyan (maximum energy 10.5 MeV). Results show that it is necessary to include (n,2n) and (n,3n) processes in inelastic scattering data in order to obtain acceptable agreement, indicating that the Yiftah-Sieger set needs modifications in the higher-energy groups. (auth)

13820 COMPUTER CODES FOR SHIELDING AND RELATED CALCULATIONS: 1972. Maskewitz, B. F.; Clark, F. H.; Trubey, D. K. (Oak Ridge National Lab., TN). Nucl. Eng. Des.; 22: No. 2, 334-41(1972).

Summary descriptions of available computer codes are brought up to date. (M.H.R.)

13821 MONTE CARLO CALCULATION OF NEUTRONS TRANSMITTED THROUGH MATTER. Hirayama, H.; Nakamura, T. (Kyoto Univ.). Mem. Fac. Eng., Kyoto Univ.; 34: No. 2, 187-200(Aug 1972).

The neutron Monte Carlo code, CYGNUS, written in Fortran IV, has been shown. This code can easily be used for several limited geometries and requires considerably less computing time than O5R. Two methods of calculation are described: one by weight and the other by collision density. Two techniques for determination of the anisotropic scattering angle in the center-of-mass system, i.e., Legendre expansion and Coveyou technique, and the method for determination of excited levels in inelastic scattering are also described. The results calculated with CYGNUS are compared with the numerical solution by PALLAS for the scalar flux in water and graphite spheres, and with experimental spectra for the angular neutron flux in water and iron shields. The agreement obtained between the CYGNUS calculations and numerical or experimental results is good. (auth)

13822 SHIELD TO REDUCE EXPOSURE TO RADIOACTIVITY. Strauss, Hyman. Amer. J. Obstet. Gynecol; 113: No. 6, 852-3(15 Jul 1972).

This device, known as the Strauss Gonad Therapy Shield, is 9½ inches wide, 10 inches high, 1¾ inch thick, and weighs ~200 pounds. The metal housing is built of ⅛-inch steel and is filled with lead shot. Repeated meter readings have indicated that more than 90% of the gamma radiation is attenuated. The frame is mounted on high-grade ball bearing wheels with special conductive rubber tires ⅞ inch wide and 3 inches in diameter. Below and lateral to the shield on both sides, there is a 4-inch foot rest. The top of the shield is 36 inches from the floor while the base of the frame stands 5 inches from the floor. The frame itself measures 18 inches both laterally and anteroposteriorly. Its width is such that it can easily be used in treating a patient in the lithotomy position. In spite of its weight, the shield is mobile to a surprising degree. The center of gravity and construction are such that it is delicately balanced to avoid tilting and capsizing and can be moved around easily with little effort. Its design allows for operating room utilization because of conductive wheels and a dragging chain to eliminate the hazard of explosion. It can be stored in minimal space in a utility closet. (auth)

PHYSICS (SOLID-STATE)

Refer also to abstract 11663.

Radiation Effects

Refer also to abstracts 12586, 12965, and 12979.

13823 (AD-743987) ZERO-PHONON LINE ABSORPTION SPECTRA OF RADIATION DAMAGE CENTERS IN SILICON. Wilson, K. B. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 102p. (GNE/PH-72-11). NTIS.

Thesis.

Infrared absorption measurements were made for n-type silicon samples irradiated with 1-MeV electrons at room temperature. The absorption spectra in the range 1 to 3 microns were recorded at both liquid nitrogen and liquid helium temperatures. Three families of zero-phonon lines and phonon-assisted sideband structure were seen which correspond to those seen in luminescence spectra. The families at 0.4891 eV and 0.7898 eV were seen only in pulled samples, while the family at 0.9702 eV was seen in both pulled and float-zone samples. A dose-rate study indicated that all three families are independent of each other. The zero-phonon lines at 0.7898 eV, 0.7948 eV, and 0.4891 eV may be from the divacancy. (auth)

13824 (BNL-17456) DEFECT STATE ANALYSIS. Goland, A. N. (Brookhaven National Lab., Upton, N. Y.). 1972. 15p. (CONF-721205-1). Dep. NTIS.

From Meeting on critical questions in fundamental radiation damage research; Washington, D. C. (5 Dec 1972).

A discussion is given of old and new techniques for determining as directly as possible the parameters describing defects in radiation damage: electrical resistivity recovery, field ion microscopy, electron microscopy, positron annihilation, x-ray diffuse scattering and anomalous transmission, relaxation techniques. 20 references. (D.L.C.)

13825 (CEA-CONF-2110) HEAVY PARTICLE CHANNELING. Mory, Jean (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 26p. (In French). (CONF-720962-1). Dep. NTIS (U. S. Sales Only).

From Modern observation methods in physical metallurgy conference; Villard-de-Lans, France (18 Sep 1972).

General laws about the slowing down of charged particles in materials and channeling theory are reviewed. Experiments performed to study channeling and dechanneling are presented, and the following applications are given: crystal orientation, ion implantation, the localization of impurities, studies of radiation damage, and crystal defects. (54 references). (France)

13826 (CEA-R-4389) METHOD OF CALCULATING THE NUMBER OF ATOMS DISPLACED IN IRRADIATED METALS. Norgett, M. J.; Robinson, M. T.; Torrens, I. M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1972. 12p. (In French). Dep. NTIS (U. S. Sales Only).

A simple procedure is proposed for calculating the number of atomic displacements produced in a damage cascade by a primary knockon atom of known energy. The formulas were chosen to give results in close accord with recent computer simulations of radiation-damage phenomena. The proposed new standard is compared with other empirical formulas for estimating the number of atomic displacements in a cascade. (auth)

13827 (IAE-2100) RADIATION ANNEALING OF FRENKEL PAIRS. Al'tovskii, I. V. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 15p. (In Russian). INIS.

A primary knocked-out atom from reactor neutron radiation produces secondary defects and is slowed down. It releases its energy in the development of a cascade, which is heated to a temperature above that of the medium, causing the migration of Frenkel pairs and their annihilation (radiation annealing). A system of equations was written that describes the diffusion and annihilation of defects and also the cooling off of the cascade zone on account of the lattice and electron thermal conductivity. The solution of the system, with simplifying assumptions, leads to a conclusion concerning the effectiveness of Frenkel pair formation by the primary knocked-out atoms. The latter possess an energy lower than some cutoff energy, and lose it in an area of small dimensions, strongly heating and producing an intense radiation annealing of the Frenkel pairs. A power exponent of nearly three is required to describe this phenomenon of the proper number of knocked-out atoms. Formulas for the number of secondary knocked-out atoms were obtained for metals and dielectrics with allowance for the temperature of the irradiated material. (tr-auth)

13828 (IAE-2101) BUILDUP KINETICS OF FRENKEL PAIRS UNDER IRRADIATION. Al'tovskii, I. V. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 11p. (In Russian). INIS.

Annealing of Frenkel pair defects may be determined by sinks or by the formation of pair defects and recombination. Independently of this, the concentration of more mobile defects during irradiation passes through a maximum, the magnitude and position of which is associated with parameters fixed by the conditions of irradiation and by the character of the defects themselves. In the case of irradiation of pure metals, the position of the maximum facilitates the determination of the activation energy of migration of interstitial atoms. (tr-auth)

13829 (IEA-256) CONTINUOUS MODEL FOR TL TRAPS. Watanabe, Shigueo; Morato, Spero Penha (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1971. 18p. Dep. NTIS (U. S. Sales Only).

Analysis of glow curves in natural CaF_2 demonstrated that some glow peaks in this material do not obey the simple model of thermoluminescence proposed by Randall and Wilkins. In particular, these peaks do not decay exponentially during isothermal heating and, moreover, the peak positions change during such treatment. A model based on the superposition of two peaks was first proposed, wherein two closely spaced, unresolved peaks were assumed to add to give the observed behavior. The calculations revealed that this model can reasonably well explain the isothermal decay curves, but not the isothermal change in the peak position. As a result, a second model was developed based on a narrow, continuous distribution of trap depth, thus modifying the model of Randall and Wilkins which is based on only one distinct trap depth. This second model, which supposes a Gaussian distribution for the trap depths, was used to explain the behavior of two glow peaks in natural CaF_2, giving satisfactory fits for the glow curve, for the isothermal decay, and for the isothermal change in the peak position. The application of this model also enables calculation of the trap parameters, which had not been previously accomplished. Analysis based on this continuous model was also extended to similar behavior of 280 and 370°C peaks in the glow curve of dosimetric LiF: Mg. Isothermal decay and isothermal change in the position of these peaks were measured for this material. (auth)

13830 (N-72-26551) OPTICAL ABSORPTION IN FUSED SILICA AT ELEVATED TEMPERATURES DURING 1.5-MeV ELECTRON IRRADIATION. Smith, A. B. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jun 1972. 36p. (NASA-TN-D-6840; E-6595). NTIS.

An experimental determination of the optical transmission of Corning 7940 UV and Suprasil 1 and 2 fused silica was made during 1.5-MeV electron bombardment. The fused silica reached temperatures ranging from 150 to 1000°C. The dynamitron provided electron current densities which corresponded to a dose rate of 2.6 to 20 Mrad/sec. The induced absorption was measured at 215.0, 270.0, and 450.0 nm. The length of each irradiation was sufficient so that an equilibrium between radiation-induced coloration and high-temperature annealing was reached. The experimental results indicate a significant optical absorption, with values of the induced absorption coefficient at 215.0 nm of 14.5 to 2.2/cm, at 270.0 nm of 9.7 to 3.0/cm, and at 450.0 nm of 3.7 to 0.5/cm. This would make the use of fused silica as the separating wall material in the nuclear light bulb propulsion concept questionable. (auth)

13831 (TID-26221) MEASUREMENTS OF THE UV AND VUV TRANSMISSION OF OPTICAL MATERIALS DURING HIGH-ENERGY ELECTRON IRRADIATION. Palma, G. E. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. Contract SNPC-70. 51p. (L-990929-3). Dep. NTIS.

The optical transmission of fused silica, BeO, MgF_2, and LiF was measured at vacuum ultraviolet wavelengths in the range 1550 to 2000Å during ambient-temperature, 1.5-MeV electron irradiation at ionizing dose rates to 0.5 Mrad/sec. The optical transmission of fused silica and BeO was also measured in the range 2000 to 3000Å during high-dose-rate, elevated-temperature 1.5-MeV electron irradiation. In particular, accurate measurements of the optical transmission were made at ionizing dose rates as high as

10 Mrad/sec. In the final portion of the program, the optical transmission of fused silica and BeO was measured in the wavelength range 2000 to 3000Å during pulsed 5- and 7-MeV electron irradiation from the LINAC accelerator. The maximum time-averaged ionizing dose rate was limited to 0.75 Mrad/sec due to accelerator limitations. (D.L.C.)

13832 STRUCTURE CHANGES DURING AGEING IN ALUMINUM 4 WT. PERCENT COPPER ALLOY STUDIED BY THE CHANNELING TECHNIQUE. Hellborg, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Scr.; 5: No. 4-5, 219-23(1972).

By use of the channeling technique, an attempt to study precipitations of copper atoms in single crystals of aluminum–4 wt.% copper alloy was made. It was found that the stable phase, θ, gives an aligned yield in Rutherford backscattering spectra quite different from the unstable phases preceding θ. The channeling measurements were correlated with electron microscopy studies on the same ageing stages. (auth)

13833 STUDY OF DEFECTS PRODUCED IN Au BY ELECTRONS. Ruault, M. O.; Jouffrey, Bernard (CNRS, Toulouse). Compt. Rend., Ser. B; 275: No. 13, 451-4(25 Sep 1972). (In French).

A 3.5-MV electron microscope was used to directly observe the evolution of the defects produced in Au during electron bombardment. (France)

13834 COLLISION THEORY OF DISPLACEMENT DAMAGE. Sigmund, P. Rev. Roum. Phys.; 17: No. 9, 1079-1106(1972).

In this lecture, the author concentrates on two theoretical aspects: (1) application of collision cascade theory to evaluate yield and energy of sputtered atoms, and (2) interpretation of spot patterns in single-crystal sputtering. Considerable space is devoted to recent arguments on the significance of linear collision chains (focusons) in sputtering. (70 references) (L.M.T.)

13835 ESR AND ENDOR STUDY OF A RADIATION DEFECT IN LiF. Brown, D. D. Lafayette, IN; Purdue Univ. (1972). 107p. University Microfilms Order No. 72-30,863.

Thesis.

A new paramagnetic defect, designated the H_R center, was discovered in LiF. This defect was produced by either x ray or electron irradiation at low temperatures. An ESR and ENDOR analysis was conducted. The analysis shows that the defect is an H center whose molecular axis has been tilted 10.7° away from the [111] direction toward [100] in a (110) plane. The agent responsible for the tilt was not ascertained, but the three most likely candidates are: a lithium interstitial, an impurity interstitial, or a substitutional negative ion impurity. The principal values and orientations of the ENDOR hyperfine tensors were obtained for 9 nonequivalent sets of lattice nuclei by fitting the ENDOR spectrum to a spin Hamiltonian. (Diss. Abstr. Int., B)

13836 NATURE OF HOLE CENTERS IN IRRADIATED ALKALI SILICATE GLASSES. Zamotrinskaya, E. A.; Torgashinova, L. A.; Anufrienko, V. F. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 6, 993-1000(Jun 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 6, 1136-40(Jun 1972).

The form of the spectrum of the low-alkali-type hole centers is analyzed, and the possibility of using the formalism of the hole-type O^- center in the field of the tetrahedron to represent the nature of these centers is evaluated. (J.R.D.)

13837 ELECTRON SPIN RESONANCE OF NITROGEN-ION-IMPLANTED SILICON. Matsumori, T. (Tokai Univ., Tokyo); Takeda, K.; Kobayashi, T.; Izumi, T.; Maekawa, H. Tokai Daigaku Kiyo Kogakubu; 1972: No. 1, 1-7(Sep 1972). (In Japanese).

Measurements of ion-implanted nitrogen in silicon at room and liquid-helium temperatures, respectively, by ESR are presented. Before annealing, a signal due to the paramagnetic defect center, whose g-value is 2.0061 ± 0.0005, is observed. This signal disappears after annealing at 500 to 600°C. In the samples implanted under the condition of 100 keV and 1×10^{15} doses, the carrier concentration approaches the maximum value after annealing at 800°C. The EPR hyperfine spectra of the implanted nitrogen are observed using these samples. (auth)

13838 MEMORY EFFECT IN ADSORPTION AND CATALYSIS ON SEMICONDUCTORS. Constantinescu, M.; Segal, E. (Center for Physical Chemistry, Bucharest). Int. Chem. Eng.; 12: No. 4, 581-90(Oct 1972).

The memory effect in the case of irradiation of semiconductors is present in four forms, namely: (1) increase in the adsorptive capacity in darkness as a result of pre-irradiation: (2) decrease of the capacity of photosorption; (3) the postradiative effect; and (4) the photocatalytic memory effect. There exist two types of theoretical treatment of the memory problem, namely: one which considers as adsorption sites the charge carriers created following irradiation, and another which considers the adsorption sites constituted by the nonequilibrium charge carriers created as a result of irradiation and localized on the biographical surface defects. (24 references) (auth)

13839 ANALYSIS OF POINT DEFECT STATES IN COPPER. V. TEMPERATURE DEPENDENCE OF THE DEFECT PRODUCTION BY ELECTRON IRRADIATION. Becker, D. E.; Dworschak, F.; Wollenberger, H. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi (b); 54: No. 2, 455-62(1 Dec 1972).

The temperature dependence of defect production was investigated by irradiating high-purity copper samples with 3-MeV electrons in the temperature range 50 to 207°K. From the initial damage rate, the capture radius of the vacancy for migrating interstitials is derived. The observed temperature dependence of the capture radius can be accounted for by a drift diffusion of the interstitials in the elastic strain field of their native vacancy. (auth)

13840 THERMAL STABILITY OF TRACKS MADE BY FISSIONING NUCLEAR FRAGMENTS ON THE SURFACES OF NONMETALLIC CRYSTALS. Geguzin, Ya. E.; Vorob'eva, I. V. (Kharkov State Univ.). Dokl. Akad. Nauk SSSR; 205: No. 2, 325-7(11 Jul 1972). (In Russian).

The thermal stability of s tracks in single crystals of muscovite (mica), lithium fluoride, and gypsum caused by fission fragments from ^{252}Cf was studied. Following irradiation, the samples were periodically annealed and examined with an electron microscope. The tracks were classified into two groups, depending upon the size of the angle between the direction of a fission fragment and the projection of its trajectory on the crystal surface. The period of time required at each annealing temperature to anneal out tracks in a given crystal was determined; temperature ranges selected varied widely: e.g., 45 to 100°C for LiF, and 160 to 360°C for mica. "Healing" of s tracks occurred chiefly as a result of diffusion absorption of the tubercles in the defect region. (KSW)

13841 COLLECTION OF IONS IMPLANTED IN SEMICONDUCTORS. 2. RANGE DISTRIBUTIONS DERIVED FROM COLLECTION AND SPUTTER-ETCH CURVES. Carter, G.; Baruah, J. N.; Grant, W. A. (Univ. of Salford, Eng.). Radiat. Eff.; 16: No. 1-2, 107-14(Sep 1972).

Collection curves for the implantation of the heavy ions Kr and Tl into the semiconductors GaAs, GaP, Ge, and Si are analyzed using a previously published theory. Sputter-etch experiments in which previously implanted ions are released by further sputtering are also described. The data from both collection and sputter-etch experiments provide information on the implanted-ion-concentration profile and on the differential ion-range-probability distribution. Results indicate that the latter distribution is wider than the expected Gaussian and that values of the sputtering coefficient necessary to match the experimental range profiles to the theoretical profiles are far larger than would be expected for target erosion. These results show that other processes than simple target sputtering are important both in determining the saturation of a target in collection experiments and in the erosion of the target to reveal the implant profile in sputter-etch experiments. (auth)

13842 INFLUENCE OF RADIATION AND SAMPLE DIMENSIONS ON THE CHARACTERISTICS OF A DISCHARGE ALONG THE SURFACE OF EPOXY COMPOUND IN A VACUUM. Isamukhamedov, S. D.; Khamidov, N.; Kudratillaev, A. S.; Sadykov, K. S. Dokl. Akad. Nauk Uzb. SSR; No. 6, 30-2(1971). (In Russian).

The effect of ^{60}Co-emitted γ radiation on discharge characteristics on an epoxy surface was investigated in a vacuum for various absorbed γ doses up to 10^{10} Rad. The samples contained 100 parts resin ED-6, 200 parts pulverized quartz sand, and 25 parts of hardener, and had been cleaned and polished prior to the experiments. A 50-Hz alternating current was used to determine the breakdown potential of the epoxy samples: 20 kV/cm before irradiation. Radiation doses of up to 10^{10} Rad had no effect on this value. The electric susceptibility was 105 kV/cm before irradiation, remained constant up to 10^8 Rad, and then dropped off sharply to about 60 kV/cm for about 10^8 Rad and above. (KSW)

13843 ELECTRON-MICROSCOPE STUDY OF CHARGED CENTERS IN γ-IRRADIATED POLYMERS. Kabanov, V. Ya.; Chalykh, A. E.; Aliev, R. E.; Luk'yanovich, V. M.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 2, 393-5(11 Jul 1972). (In Russian).

Electric charges generated on the surface of polymers during radiation grafting influence both the initiation of the grafting process and the microstructure of the growing chain. In order to elucidate the phenomenon of charged centers, the electrical topog-

raphy was investigated by the method of surface decoration by electrically charged particles and then by examination of that surface by transparent electron microscopy. High-pressure polyethylene was irradiated by ^{60}Co gamma rays and then immersed in a dispersed latex (diameter 1,000 to 1,200 Å). Electron-microscope photographs of the morphology of the surface revealed only negative charges on the irradiated polyethylene film, whether the irradiation had been performed in air or in a vacuum. (KSW)

13844 FORMATION AND DESTRUCTION OF M CENTRES IN KCl BY AN IONIZING RADIATION AT ROOM TEMPERATURE. Herrmann, F. (Institut National des Sciences Appliquees, Villeurbanne, France). Cryst. Lattice Defects; 3: No. 3, 167-9(Aug 1972).

The rate of destruction of M centres in KCl at RT by electron irradiation was found to be proportional to $j \cdot n_M/n_F$, with n_F and n_M the F and M centre concentrations and j the current density. It follows that the formation rate is proportional to the first power of n_F. It is concluded that α centres are formed in the primary creation process of radiation defects. (auth)

13845 INTERSTITIAL AND TRAPPED-HOLE CENTERS IN ALKALI HALIDES. Itoh, N. (Nagoya Univ., Japan). Cryst. Lattice Defects; 3: No. 3, 115-43(Aug 1972).

Experimental and theoretical studies of the interstitial and trapped-hole centers in alkali metal halides are surveyed. The most fundamental interstitial centers are the isolated atom interstitial center, the H center and the isolated ion interstitial center, the I center. The former has been identified clearly by EPR and ENDOR experiments. Some circumstantial evidence for the existence of the latter has been presented. Two types of motion of interstitial centers are of primary importance: thermal motion of the I and H centers and motion of atom crowdion. Experimental results on thermal motion and crowdion motion are reviewed, although only little information has been obtained on the motion of the crowdion. The interaction of interstitial centers plays an important role in the formation of Frenkel pairs. Both atoms and ion interstitial centers associated with impurities are presented, and their properties as well as the nature of interaction force are discussed. Coulomb and elastic forces are considered to be the main cause of interaction. Interaction between two H centers is also discussed. This interaction takes place both during thermal migration and during crowdion motion. The qualitative electronic properties of the atom interstitial centers as well as the V_k center are described well in terms of those of the X_2^- molecule ion. The detailed electronic properties, however, are affected by the coupling with the valence band. Although the properties of the interstitial ion centers are not known very well, it is shown that a p-electron of an interstitial halogen is excited leaving a missing p-shell, which relaxes into an X_2^- molecule ion. (auth)

13846 TEMPERATURE DEPENDENCE OF F-CENTRE ABSORPTION IN NaCl. Jacobs, P. W. M.; Parsons, L. M. (Univ. of Western Ontario, London). Cryst. Lattice Defects; 3: No. 3, 155-61(Aug 1972).

The optical absorption due to the F center in NaCl was measured on four crystals at 32 temperatures between 24 and 309°K. The total band envelope was resolved into two components one for the 1s−2p transition (F band) and the other an asymmetric envelope of the 1s−np transitions (K band). It is shown that the F-band parameters are unchanged if up to four components for the K band are used in the computer resolution. Values of four parameters (effective frequency ν_a of the mode that couples with the ground state (a); photon energy at maximum absorption E_m; ratio of the force constants for the excited and ground states K_b/K_a; and $\frac{1}{2}Kaq_0^2$, where q_0 is the displacement of the minimum in the excited state adiabatic potential curve from that for the ground state are obtained by fitting the absorption curves to the theoretical equation derived from the configuration coordinate model. There are some advantages in determining ν_a first from the temperature dependence of the half-width. The fact that the values of the parameters K_b/K_a and $\frac{1}{2}Kaq_0^2$ depend on whether the high-temperature or low-temperature data are being analyzed suggests some inadequacies in the model. Mean values of these parameters are used to predict the temperature dependence of E_m. Even after correction for thermal expansion, the temperature dependence of E_m is greater than that predicted which suggests that the ratio of the expansivity α to the compressibility β has a larger value around the defect than it does in the bulk crystal. Since β is somewhat larger in the vicinity of the defect than in the bulk crystal, this result implies that $\alpha_{loc}/\alpha_{bulk}$ is ~1.6. (auth)

13847 THERMOLUMINESCENCE OF X RAY IRRADIATED NaCl AND NaCl:Pb CRYSTALS. Sastry, S. B. S.; Viswanathan, V.; Ramasastry, C. (Indian Inst. of Tech., Madras). J. Phys., C (London); 5: No. 24, 3552-65(12 Dec 1972).

Thermoluminescence of "pure" and lead-doped NaCl crystals obtained in the range of 300 to 600°K after room-temperature irradiation with x rays is reported. Three heating rates 40, 80, and 140°C min^{-1} are employed in taking the glow curves. In the case of pure NaCl three prominent peaks I_1, F_1, and F_2 are observed. They are respectively attributed as due to the release of electrons from impurity centers (accidentally present), first and second stages of F centers. In the doped crystals, four peaks L_1, L_2, F_1, and F_2 are observed. The first two are attributed to the release of electrons from Pb^+ and Pb^0 centers in the crystal formed during irradiation. F_1 and F_2 are due to the bleaching and recombination of F center electrons as in the pure crystal. Analysis is made by the "total curve fitting method" using a formula due to Randall and Wilkins and the trap depths for various glow peaks are estimated. The high value of the frequency factor, s, obtained for the F_2 peak ($\simeq 10^{22}$ s^{-1}) is discussed qualitatively and is consistent with a model that thermal annealing of interstitials and recombination with F centres takes place during the thermoluminescence run and the emission of light occurs as a sudden burst at a certain temperature. The emission of the F band is in the 480- to 510-nm region and the emission due to L_1 and L_2 peaks occurs around 332 and 398 nm. (auth)

13848 TEMPERATURE DISTRIBUTION IN A BEAM IN THE PRESENCE OF EXCITED STRUCTURES: THEORY OF CHANNELING AND THE SHADOW EFFECT IN THE STATISTICAL MODEL OF A CRYSTAL. Vlasov, A. A.; Kuraev, V. N. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 4, 431-7 (1972). (In Russian).

Channeling theory and the shadow effect are discussed on the basis of nonlocal statistical description of particles of a crystal, allowing for the collective interaction of particles of the beam with the crystal as a whole. (tr-auth)

13849 CHANNELING THEORY AND SHADOW EFFECTS IN EXCITED STATES OF A CRYSTAL. Vlasov, A. A.; Kuraev, V. N. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 4, 471-4(1972). (In Russian).

Channeling theory and shadow effects and difficulties in the quantitative description of spot and line width are discussed relative to their dependence on energies of incident particles and on the crystal temperature. In an effort to avoid some of these difficulties, attention was turned to the filamentary and laminated structures, assuming that they are excited in the crystal by the same beam of fast particles. Different scattering results are to be expected in the case of filamentary and laminated structures as a result of the appearance of new potentials that interact with the beam particles. (KSW)

13850 ANNEALING PROCESSES IN GERMANIUM CONVERTED INTO p-TYPE BY 1-MeV ELECTRONS. Kraitchinskii, A.; Rzewuski, H.; Suski, J.; Werner, Z. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 17: No. 7-8, 399-404 (1972).

Annealing processes occurring in the temperature range 180 to 300°K in n-type germanium converted into p-type by 1-MeV electron irradiation at about 140°K were studied. Three processes were examined: the first one in the range of 90 to 120°K, the second one in the range of 180 to 200°K, and the third one in the range of 280 to 300°K. It was found that the process at 90 to 120°K is governed by a second-order kinetics with an activation energy of 0.28 eV. A simple model explaining the kinetics of the 90−120°K process is presented. It was observed that the process 180−200°K shifts into the lower temperature range when annealing is performed with ionizing radiation of subthreshold electrons. The 280−300°K process is not affected by ionization background. The results indicate that the general character of the annealing processes in germanium depends on the charge state of defects rather than on the type of chemical impurity. (auth)

13851 PECULIARITIES IN ELECTRIC CONDUCTIVITY OF ANTIFERROMAGNETIC METALS (Cr, Pr) IN THE TEMPERATURE RANGE 0.3 TO 300°K. Semenenko, E. E.; Tutov, V. I. (Physical-Technical Inst., Kharkov). Izv. Akad. Nauk SSSR; Ser. Fiz.; 36: No. 7, 1412-15(Jul 1972). (In Russian).

The electrical resistance of Cr and Pr with various amounts of the impurity Fe present was studied over the temperature range 0.36 to 320°K. Minima in resistance were observed for all samples tested: for Cr of the highest purity, $T_{min} \sim 5°K$; at the lowest purity, $T_{min} \sim 11°K$. For Pr with 0.020% Fe, T_{min} was 0.9°K; with 0.035% Fe, T_{min} was 1.8°K. (KSW)

13852 SPATIAL DISTRIBUTION OF DEPOSITED ENERGY AND LATTICE DEFECTS IN SEMICONDUCTORS BOMBARDED WITH ENERGETIC HEAVY IONS. Tsurushima, T.; Tanoue, H. Denki Shikensho Iho; 36: No. 7, 495-515(1972). (In Japanese).

A new general principle is described that provides a simple and direct method for predicting the spatial distribution of energy absorbed in nuclear collisions, especially in atomic displacement processes in heavy ion-bombarded semiconductor materials. To calculate the energy transfer rate into atomic displacements, an energy distribution function of incident ions at an arbitrary penetration depth is derived and integrated together with a weight function based on the total cross section for the production of displaced atoms and the average energy transfer corresponding to those encounters that can displace atoms in the substrate materials. Numerical data obtained in each procedure of the method are presented and compared with various theoretical and experimental results previously published. The average number of knock-on atoms produced by an incident ion and associated knock-ons is calculated in a unique manner. Problems of the vacancy distribution and the amorphization criterion are also discussed. Theoretical curves of deposited energy distribution for various ions implanted in silicon are included. 33 references. (auth)

13853 INFLUENCE OF ION BOMBARDMENT ON PHYSICAL AND PHYSICOCHEMICAL PROPERTIES OF SILICON. Ablyaev, Sh A.; Chirva, V. P.; Arsenin, V. V. pp 65-7 of Secondary Emission and Structural Properties of Solids. /Arifov, U. A. (ed.). New York; Plenum Publishing Corp. (1971).

An investigation was conducted on p- and n-type Si irradiated with Cs, Li, B, Sb, and Si ions at energies up to 50 keV. The volt–ampere characteristics were measured and optical interference microscopic observations made. Thermal annealing of irradiated samples in H at 500°C reduced the rectification factor. Photodiodes were made and their spectral characteristics after annealing in H were determined. (DLC)

13854 BEHAVIOR OF MAGNETOPHOTOCONDUCTIVITY OF SEMI-INSULATING GaAs UPON α-PARTICLE BOMBARDMENT. Euthymiou, P. C.; Nomicos, C. D.; Philadelpheus, A. Th. (Univ., Athens). J. Appl. Phys.; 44: No. 1, 521-2(Jan 1973).

The effect of 2-MeV α particles on the magnetophotoconductivity of semi-insulating GaAs single crystals mounted in the Voigt geometry was investigated at 300°K. Upon bombardment of the specimen, an increase of the positive branch of the magnetophotoconductivity resulted, while the negative branch remained unaltered. The increase is attributed to a decrease of carrier lifetime in the damaged surface region. The negative branch remains constant since the α particles do not influence the bulk properties. (auth)

13855 SOLID-STATE ELECTRONIC STRUCTURE EFFECTS OF SILICON K_β X-RAY SPECTRA PRODUCED IN α-PARTICLE EXCITATION. Moore, C. F.; McWherter, J.; Olsen, D. K.; Richard, P. (Center for Nuclear Studies, Austin, TX). J. Appl. Phys.; 44: No. 1, 519-20(Jan 1973).

Both Si and SiO_2 crystals were bombarded by a 3.2-MeV α-particle beam and the subsequent Si K x-ray yield was measured. The K_α x-ray spectra show fairly close agreement; however, the structure in the K_β x-ray spectra is quite different for Si and SiO_2. These results are interpreted as effects due to the chemical bonding of the oxygen atoms to silicon. (auth)

13856 PHOTOLUMINESCENCE FROM He, Ar, Fe, AND Cr ION-IMPLANTED MgO. Crawford, J. R.; Dragsdorf, R. D. (Kansas State Univ., Manhattan). J. Appl. Phys.; 44: No. 1, 385-8(Jan 1973).

Powdered and single-crystal MgO, implanted with 60-keV He, Ar, Fe, and Cr ions, were examined by laser-stimulated photoluminescence. The photoluminescence from damage-related defects, centered at 14,350 cm^{-1}, and from $MgO:Cr^{3+}$ zero-phonon line at 14,325 cm^{-1} are discussed. The annealing behavior of the introduced defects and impurities is characterized by the room-temperature and liquid-nitrogen-temperature photoluminescence observed before and after 1-h anneals of 325, 600, and 900°C. A comparison is made between the ion-implanted and the impurity-grown systems. Speculation is made on the nature of the damage-related defects as the source of the broad emission centered at 14,350 cm^{-1}. Correspondence to the previously observed absorption band at 17,420 cm^{-1} is made. (auth)

13857 DOPING OF SILVER BROMIDE BY ION IMPLANTATION. Helling, J. O.; Keevert, J. E.; Kelly, T. M.; Merrigan, J. A. (Eastman Kodak Co., Rochester, NY). J. Appl. Phys.; 44: No. 1, 329-30(Jan 1973).

The effects of implanting silver, phosphorus, and cadmium ions in silver bromide microcrystals were ascertained, using the intrinsic photosensitivity of these devices. Defects caused by implantation controlled the photocarrier trapping. After removal of these defects by annealing, both cadmium and phosphorus were the controlling species and increased the internal photosensitivity of the microcrystals. (auth)

13858 DEPTH DISTRIBUTIONS OF DEFECTS AND IMPURITIES IN 100-keV B^+ ION-IMPLANTED SILICON. Akasaka, Y. (Mitsubishi Electric Corp., Hyogo, Japan); Horie, K.; Yoneda, K.; (and others). J. Appl. Phys.; 44: No. 1, 220-4(Jan 1973).

The depth distributions of boron atoms and of radiation-induced defects are measured in the same set of silicon samples implanted with 100-keV boron ions at room temperature to a dose of $1 \times 10^{16}/cm^2$, by utilizing the $^{11}B(p,\alpha)^8Be$ nuclear reaction and by channeling analysis with 1.5-MeV He^+ ions, respectively. Distributions of both boron atoms and the primary defects are asymmetric and significantly deviated from the Gaussian distribution. The width (FWHM) of the damage distribution is about 0.26 μ and is much larger than that of boron distribution which is 0.09 μ. The peak of the primary defect distribution is about 15% shallower than that of the boron distribution. The secondary defects have a Gaussian distribution, the peak depth of which almost coincides with that of boron distribution. The correlation between the electrical and the channeling measurements is also studied, and it is suggested that the secondary defects are strongly associated with boron atoms. (auth)

13859 ELECTRICAL AND OPTICAL PROPERTIES OF PROTON-BOMBARDED GALLIUM PHOSHIDE. Spitzer, S. M.; North, J. C. (Bell Telephone Labs., Murray Hill, NJ). J. Appl. Phys.; 44: No. 1, 214-19(Jan 1973).

The electrical and optical properties of proton-bombarded p- and n-type liquid-encapsulated Czochralski-grown GaP were investigated as a function of 300-keV proton dose and subsequent annealing. Proton bombardment of GaP introduced lattice damage into a surface layer equivalent in thickness to the proton penetration range, and resulted in a large increase in the electrical resistivity, as well as an increase in optical absorption of this damaged surface layer. The thickness of the damaged layer increased linearly with proton energy at approximately 1.0 μ/100 keV in the energy range from 100 to 300 keV. Electrical resistivity in both p- and n-type samples increased with proton dose to a maximum of $\sim 10^{14}$ Ω cm at a dose of 4×10^{14} protons/cm^2, and then the resistivity decreased with increasing dose. Optical absorption spectra indicated a continuous distribution of energy levels extending into the band gap. The absorption at 6328 Å (visible red) increased monotonically with proton dose from ~10% and 10^{14} protons/cm^2 at 300 keV to ~90% at 10^{17} protons/cm^2. Layers approximately 3.0 μ thick were produced which have high electrical resistivity (>10^{10} Ω cm) and relatively low optical absorption (<10%). The activation energies governing the annealing of the optical and electrical defects are in the range from 2 to 4 eV. The existence of large activation energies for the annealing of bombardment-induced high resistivity implies high stability near room temperature. This stability combined with ease of forming high-integrity pinhole-free layers of controlled thickness on GaP substrates suggests useful applications in the GaP device fabrication technology. Many qualitative similarities were observed between the proton-bombarded GaP and the bombarded p-type GaAs studied earlier. (auth)

13860 OPTICAL AND ELECTRICAL PROPERTIES OF PROTON-BOMBARDED p-TYPE GaAs. Dyment, J. C.; North, J. C.; D'Asaro, L. A. (Bell Telephone Labs., Murray Hill, NJ). J. Appl. Phys.; 44: No. 1, 207-13(Jan 1973).

The effect of 300-keV proton bombardment and subsequent annealing on the optical absorption and electrical resistivity of bulk p-type ($p = 2 \times 10^{18}$ and 1.4×10^{19} cm^{-3}) GaAs was studied. Proton doses were in the range 10^{13} to 10^{17} cm^{-2}. It is found that bombardment-induced optical absorption increases monotonically, but sublinearly, with proton dose. The shape of the optical transmission spectrum indicates that bombardment creates a distribution of energy levels extending into the forbidden gap. Activation energies for annealing of the optical absorption were determined from isothermal annealing data and range from ~1.5 to ~3.4 eV, which indicates that at least two kinds of defects are involved. Current–voltage measurements show that the average electrical resistivity of the bombarded layers goes through a maximum at $\sim 2.5 \times 10^5$ Ω cm at a proton dose of $\sim 3 \times 10^{15}$ cm^{-2}. It is shown that annealing can eliminate the bombardment-induced optical absorption while still retaining a high electrical resistivity. The optimum annealing time and temperature is a function of the proton dose. From these results a set of useful conditions for the proton-bombardment fabrication of stripe-geometry GaAs lasers is determined. Many qualitative similarities exist between the results and those obtained in GaP. (auth)

13861 ANISOTROPY OF RADIATION DAMAGE AND DISLOCATION DAMPING IN Cu. Akita, H.; Fiore, N. F. (Univ. of Notre Dame, IN). J. Appl. Phys.; 44: No. 1, 20-4(Jan 1973).

Copper single-crystal cubes were γ-irradiated in the [001] and [1$\bar{1}$0] directions, and the ultrasonic attenuation due to dislocation

damping was determined in the [1$\bar{1}$0] direction after the various irradiation treatments. Fricke dosimetry indicates that about 10% less secondary electron energy exits the crystal in the [1$\bar{1}$0] irradiation than in the [001] irradiation. The fact that more energy is absorbed in the [1$\bar{1}$0] irradiation is consistent with the dislocation damping studies, which indicate that more dislocation-pinning point defects are created in this case. The damping data obey the Granato–Lücke damping theory, and quantitative predictions as to the dislocation loop length and number of pinners created during irradiation are made on the basis of the theory. The anisotropy in radiation damage is consistent with theoretical predictions of anisotropy of replacement energy and focusing energy in Cu. (auth)

13862 DEFECT CREATION BY RADIATION IN POLAR CRYSTALS. Sonder, E.; Sibley, W. A. (Oak Ridge National Lab., TN). pp 201-90 of Point Defects in Solids. Vol. 1. /Crawford, J. H. Jr. (ed.). New York; Plenum Publishing Corp. (1972).

The primary defects that can be produced by radiation are described, and the nomenclature used to describe these defects is discussed. A summary of how radiation affects polar crystals is given; the total process of displacing an ion from its lattice site and its stabilization so that it cannot return to an empty site is considered. A review of defect production and reactions for alkali metal halide crystals and polar oxide crystals is given. (11 tables, 29 figures, 265 references) (DLC)

13863 COLLECTION OF IONS IMPLANTED IN SEMICONDUCTORS. 1. SATURATION EFFECTS. Whitton, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Carter, G.; Baruah, J. N.; Grant, W. A. Radiat. Eff.; 16: No. 1-2, 101-5 (Sep 1972).

The collection of energetic ions of Kr and Tl in Si, Ge, GaP, and GaAs was studied as a function of ion dose and energy (up to 30 keV) using radioactive ions and assay techniques for measurement. Buildup rates and saturation levels were established for the various combinations of incident ion, incident energy, and target material. The rates of buildup are monotonic and level off to a constant saturation concentration. No evidence was found for the oscillatory (factor ~2) departure from saturation level observed by Tinsley and coworkers (1971) for 20- and 60-keV Bi in GaAs. (auth)

13864 RADIATION EFFECTS ON THE ELECTRICAL PROPERTIES OF SOME DIELECTRIC MATERIALS. Oproiu, C. (Inst. of Atomic Physics, Bucharest); Nemes, M.; Sufana, N.; Ivanceanu, E. Stud. Cercet. Fiz.; 24: No. 9, 1170-1186(1972). (In Rumanian).

The radiation effects on the electrical properties of polyethylene and two sorts of polyvinyl chloride are presented. Diagrams illustrating the dielectric strength, dielectric permittivity, dielectric loss, and surface and volume resistivity variation against the absorbed dose are given. (auth)

Physical Properties

Refer also to abstracts 11863, 11914, 12471, 12484, 12498, 12500, 12502, 13391, 13392, 13513, and 14281.

13865 (CEA-R-4314) APPLICATION OF THE PERTURBED ANGULAR CORRELATION TECHNIQUE TO THE STUDY OF QUADRUPOLE COUPLING IN SOLIDS. Boyer, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jul 1972. 144p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble (France).

The potential of the differential perturbed angular correlation (D.P.A.C.) technique for the study of solid-state phenomena was examined experimentally. Metallic and insulating samples of hafnium were studied, using the ^{181}Ta 133/482 keV γ–γ cascade as a probe. The electrical-field-gradient coupling parameters were found to be strongly influenced by the lattice defects. In the case of hafnium metal, dislocations and impurities, mainly zirconium, increased the asymmetry parameter in the hcp matrix. The static and dynamic quadrupole coupling supplied data on the structure and on the relaxation of octocoordinated hafnium neutral complexes with tropolone, N-benzoyl-phenyl-hydroxylamine, cupferon, and of the tetrapotassium tetrakisoxalatohafniate ($K_4Hf(C_2O_4)_4$). The introduction of the probe ^{181}Hf by thermal neutron capture in the two first solid compounds at low temperature (77°K) has supplied new information on the site symmetries and nature of the recoil atoms. The D.P.A.C. results are compared with the parallel purely radiochemical hot-atom observations in the same systems. (auth)

13866 (CEA-R-4391) STUDY OF THE ELECTRONIC STRUCTURE OF ALLOYS AND ACTINIDES. Gatesoupe, J. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1972. 61p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Nancy Univ. (France).

Results of magnetic susceptibility at low temperature (4 to 300°K) on dilute alloys of actinides in transition metals are presented and give information on the behavior of actinides in metallic solutions: occurrence of magnetic decoupling of local configurations and perturbations in the bands of the matrices. It is confirmed that the plutonium configurations are hardly magnetic and this is attributed to the effect of spin–orbit interaction on 5f levels. The susceptibility of YTh indicates that this alloy has an f character. The abnormal behavior of the susceptibility of ScPu, TiPu, and LaPu must come from an anomaly in the spectrum of band states of the matrices near the Fermi level. That is supported by a narrow-band calculation of the resonance. (auth)

13867 (COO-2103-20) RELATIVISTIC ELECTRONIC BAND STRUCTURE AND PROPERTIES OF THE HEAVIER ACTINIDES: A SECOND RARE-EARTH SERIES. Koelling, D. D.; Freeman, A. J. (Northwestern Univ., Evanston, Ill. Dept. of Physics. Argonne National Lab., Ill.). 1972. 5p. (CONF-721114-9). Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

The heavier actinides, i.e., Am and beyond, have been studied by means of RAPW calculations and are found to differ dramatically from the lighter metals: the 5f electrons appear to be more localized spatially, overlap only weakly with their 5f neighbors, and show band widths which are small relative to the Coulomb correlation energy. Hence, just as in the case of the rare-earth metals, the 5f electrons may not be described by the band model. Instead, a localized description is required in which, as in the rare earths, Hund's rule intraatomic exchange coupling produces localized 5f magnetic moments that can be ordered magnetically by indirect exchange interaction. (auth)

13868 (COO-2103-22) ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF SCANDIUM. Das, S. G. (Argonne National Lab., Ill.); Freeman, A. J. (Northwestern Univ., Evanston, Ill. Dept. of Physics. Argonne National Lab., Ill.); Koelling, D. D. (Northwestern Univ., Evanston, Ill. Dept. of Physics); Mueller, F. M. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill. Dept. of Physics). 1972. 6p. (CONF-721114-15). Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

The band structure of scandium was studied on the basis of two different models: (1) an ab initio calculation using the relativistic APW method and (2) an interpolation scheme which used s-, p-, and d-type functions in the tight-binding representation. The warped muffin-tin APW potential was obtained from overlapping charge densities which were derived from the atomic configuration $3d4s^2$ and exchange interaction based on the Slater approximation. The Hamiltonian of the interpolation scheme was parameterized in terms of 16 parameters in a two-center approximation. The total density of states, the factorized s and d density of states, etc., appear to be in good agreement with the experimental magnetic susceptibility. A discussion is given of the "s"-band contribution to the Knight shift and the relation of the factorized density of states belonging to the representations A_1', E', and E'' to the measured nuclear spin relaxation time and the anisotropy in the magnetic susceptibility. (auth)

13869 (LBL–1138) LOW-TEMPERATURE HEAT CAPACITY OF α- AND β-CERIUM. Conway, M. M.; Phillips, N. E. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 10p. (CONF-720833–26). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO (20 Aug 1972).

The heat capacities of mixed-phase Ce samples were measured at 0.1 to 24°K and were extrapolated to the pure phases using the magnetic ordering anomaly in β–Ce. The value of γ for α–Ce is high (22 mJ/mole °K^2) and is attributable to the 4f electron which overlaps the Fermi surface. The θ_0 of α–Ce is ~125°K. The heat capacity of β–Ce is $C_\beta = 54\ T + 5.6\ T^3$ mJ/mole °K. The entropy associated with the 12.5°K antiferromagnetic ordering peak of β–Ce is ~½ R ln 2, indicating that only half of the localized 4f electrons order at that temperature. (D.L.C.)

13870 (UCRL-73923(Rev.1)) MAGNITUDE AND EXTENDED ENERGY RANGE OF X-RAY K-ABSORPTION FINE STRUCTURE FOR Ti, Fe, Co, Ni, Cu, AND Zn. Del Grande, N. K.; Oliver, A. J. (California Univ., Livermore. Lawrence Livermore Lab.). Sep 1972. 27p. (CONF-720939–2). Dep. NTIS.

From International symposium on x-ray spectra and electronic structure of matter; Munich, Germany (18 Sep 1972).

Total x-ray attenuation coefficients for six elements from Ti to Zn were measured from ~100 eV below to ~900 eV above their respective x-ray K-absorption edges. A smooth average through the data taken at ≤5-eV intervals was systematically about 10% higher at energies approaching the K-absorption edge from the high energy side than predictions based on one-electron calculations obtained numerically beginning with relativistic Hartree–Fock–Slater screened central potentials for the elements Ti, Fe, Co, Ni, Cu and Zn. Agreement was 3% or better at higher energies which were >1 keV above the K edge (e.g., 15 keV). The experimental data were taken using a highly collimated source of x rays incident on a single (LiF) crystal spectrometer in conjunction with a flow proportional counter and multichannel analyzer. Statistical fluctuations were kept below ½%. Corrections were made for dead time counting losses, backgrounds and trace amounts of elemental impurities. Total errors were ≤ 2% except for the region within 50 eV of the K-absorption edge where corrections due to resolution broadening were large. The extended fine structure for Co, Ni and Cu was strikingly similar in shape for the three fcc metals, which should enhance understanding of the basic mechanisms involved. Details of the absorption fine structure for bcc Fe differed considerably from those for the fcc metals. The Fe peaks had narrow (corrected) F.W.H.M. values: 3.2 ± .5 eV located at 12.6 eV, 20.3 eV, 32.7 eV, 40.4 eV and 48.0 eV above the K-edge and broader (corrected) F.W.H.M. values: 13 ± 1 eV from 50 eV to 600 eV above the K-edge. Effects due to sample thickness and experimental resolution were considered in detail. (auth)

13871 PRESSURE-INDUCED ELECTRONIC COLLAPSE AND SEMICONDUCTOR-TO-METAL TRANSITION IN EuO. Jayaraman, A. (Bell Telephone Labs., Murray Hill, NJ). Phys. Rev. Lett.; 29: No. 25, 1674-6(18 Dec 1972).

Pressure–volume data for EuO to 400 kbar are presented. An electronic collapse in the Eu ion involving the promotion of a 4f electron to the 5d state occurs near 300 kbar at room temperature. The structure remains NaCl type in this transformation. The transition appears to be first order and is from semiconductor to the metallic state. The collapsed NaCl phase undergoes a phase change to the CsCl-type structure near 400 kbar. (auth)

13872 ELECTRON SPIN POLARIZATION IN FIELD EMISSION FROM EuS-COATED TUNGSTEN TIPS. Mueller, N. (Max-Planck-Institut fuer Plasmaphysik, Munich); Eckstein, W.; Heiland, W.; Zinn, W. Phys. Rev. Lett.; 29: No. 25, 1651-4(18 Dec 1972).

Field-emitted electrons from EuS-coated W tips cooled to below 21°K show spin polarization of up to (89 ± 7)%. The preferential direction of the magnetic moments of the electrons is parallel to the magnetization of the emitter. The high spin polarization is explained in terms of emission from spin-polarized $4f^7$ states of ferromagnetic EuS or in terms of emission assisted by interaction with these states. (auth)

13873 LATTICE CONDUCTIVITY AND THERMAL LINEAR MAGNETORESISTANCE OF INDIUM USING THE CORBINO GEOMETRY. Van Kempen, H.; De Lang, H. N.; Lass, J. S.; Wyder, P. (Univ. of Nijmegen, Netherlands). Phys. Lett.; 42A: No. 4, 277-8 (18 Dec 1972).

Using a high-field extrapolation, the lattice thermal conductivity in a sample of pure indium between 0.4 and 1.9°K was found to be $\lambda_g = 9.5 \times 10^{-4}\ T^2$ W/cm°K. The linear magnetoresistance was shown to follow Kohler's rule. (auth)

13874 SPECIFIC HEAT OF TERBIUM VANADATE $TbVO_4$. Wells, M. R. (Clarendon Lab., Oxford); Worswick, R. D. Phys. Lett.; 42A: No. 4, 269-70(18 Dec 1972).

The specific heat of $TbVO_4$ was measured in the temperature range 0.5 to 60°K. An anomaly is observed at 33°K which is due to a Jahn–Teller distortion and the overall form of the curve is explained using molecular field theory. (auth)

13875 NEW INVESTIGATION OF THE OPTICAL ABSORPTION OF RARE-EARTH THIN FILMS. Petrakian, J. P. (Univ. de Provence, Marseille). Thin Solid Films; 13: No. 2, 269-73 (15 Nov 1972).

Thin films of holmium and all heavy rare earths exhibit an optical absorption peak whose position near 3.1 eV is not thickness dependent. This band behavior with increasing thickness shows that the phenomenon cannot be described as abnormal. Plasma oscillations are not consistent with the data. Light rare earths with a different crystalline structure do not exhibit this maximum. An electron interband transition is postulated whose energy is 3.1 eV. The energy band diagram of gadolinium gives an average theoretical energy of 3.06 eV. It agrees with experimental data obtained with natural light and polycrystalline films. (auth)

13876 MEASUREMENT OF OXYGEN-DIFFUSION-PROFILES IN SILICON-SINGLE-CRYSTALS BY MEANS OF THE NUCLEAR REACTION $^{18}O(p,\alpha)^{15}N$. Gass, J. E. (Univ., Zurich); Mueller, H. H.; Schmied, H.; Joerissen, L.; Ziffermayer, G. Nucl. Instrum. Methods; 106: No. 1, 109-13(1973).

A measurement of the oxygen concentration profile was made in silicon following diffusion (12 h at 1290°C from ^{18}O enriched SiO_2 layer source) by using the nuclear reaction $^{18}O(p,\alpha)^{15}N$. A minimum concentration of 0.3 ppM (1.5×10^{16} ^{18}O atoms/cm^3) can be detected. For thin oxide layers the detection limit is about 1×10^{13} ^{18}O atoms/cm^2 (1×10^{-10} g ^{18}O atoms/cm^2). The sensitivity was limited mainly by the presence of ^{11}B. (4 figures, 2 tables) (auth)

13877 PROBLEMATICS OF THE DERIVATION OF THE ELECTRIC FIELD GRADIENT ASYMMETRY PARAMETER FROM TDPAC MEASUREMENTS OR MOESSBAUER SPECTROSCOPY IN IMPERFECT CRYSTAL LATTICES. Forker, M. (Univ., Bonn). Nucl. Instrum. Methods; 106: No. 1, 121-6(1973).

It is shown that the common analysis of TDPAC measurements and of Moessbauer spectra taken in imperfect crystal lattices leads to an electric field gradient asymmetry parameter, η, which deviated considerably from that of the ideal crystal. This effect is especially large if the perfect crystal has an η value close to zero or one. The magnitude of this deviation was studied for TDPAC measurements by extensive model calculations for the special case $I = 5/2$. A comparison with recently published experimental η values different from zero in crystals, where $\eta = 0$ follows from the symmetry group of the ideal crystal, shows that this deviation is predominantly due to the effect discussed in this work. The knowledge of this effect and its magnitude is essential to avoid misinterpretations of experimental η values. (6 figures, 1 table) (auth)

13878 LOW-TEMPERATURE PROPERTIES OF THE LIGHT RARE-EARTH HEXABORIDES. Lee, K. N. Princeton, NJ; Princeton Univ. (1971). 131p. University Microfilms Order No. 72-14,154.

Thesis.

Experimental studies of the rare-earth hexaborides CeB_6, PrB_6, SmB_6, and EuB_6 are reported. CeB_6 ($T_N = 2.4$°K) and PrB_6 ($T_N = 6.9$°K) are antiferromagnetic metals, EuB_6 ($T_c = 8.5$°K) is a ferromagnetic semiconductor, and SmB_6 is a semiconductor with anomalous magnetic properties. Measurements of the transport properties, magnetic properties, and low-temperature specific heat are presented and discussed. New methods for measuring the heat capacity of samples in the 1- to 100-mg range are also described in detail. The measurements are interpreted using crystal-field theory and simple models of the exchange interaction. The unusual low-temperature behavior of the rare-earth hexaborides can be qualitatively described by such a framework: (1) CeB_6. The interpretation of the specific heat, using an exactly calculable variant of the Ising model, supports the proposal of Nickerson and White that the exchange interactions in the excited state of the Ce_{3+} ion might be substantially stronger than the ground-state exchange. As the excited state becomes thermally populated, then, there could be a recurrence of significant short-range order at temperatures far above the ordering temperature, as displayed in the model calculation. (2) EuB_6. The study of the spin-disorder resistivity as functions of temperature and applied magnetic field confirms the qualitative predictions of Fisher and Langer. The field dependence of the large negative magnetoresistance indicates that EuB_6 may not be a simple ferromagnet. (3) PrB_6. Transport and specific-heat measurements in this system again confirm the Fisher–Langer description. The specific-heat results, originally discussed using the theory of singlet-ground-state magnetism, are re-examined in the light of recent neutron-scattering measurements. These data show that the overall crystal-field splitting is smaller than 30°K. (4) Magnetic interactions. By regarding the magnetic rare-earth hexaborides as a family of compounds, we discuss evidence for systematic trends in the magnetic properties. The anomalous behavior of the magnetic susceptibility, in particular, suggests that the Ruderman–Kittel indirect-exchange model, with its Heisenberg form for the ion-ion coupling, may be inadequate to describe the behavior of the family systematically. (5) SmB_6. Measurements of the resistivity and Hall effect from 1 to 300°K, of the specific heat from 1 to 30°K were made, and a physical model of SmB_6 is proposed which is in agreement with these and other measurements. Using an ionic configuration made up of a trivalent Sm core (4f5) and a localized 5d electron, the magnetic susceptibility can be fitted. The effective band structure of this state leads to a three-band model which can be fitted to the transport data. It is shown that this picture is consistent with other measurements, including Moessbauer, lattice-constant, and thermoelectric–voltage studies. (TSS) (Diss Abstr. Int., B)

13879 SURFACE MODIFICATION OF POLYCRYSTALLINE RHENIUM BY THORIUM ADSORPTION USING PERIODIC DEVIATIONS IN THERMIONIC EMISSION. Pitz, P. B. Notre Dame,

IN; Univ. of Notre Dame (1972). 118p. University Microfilms Order No. 72-26,817.

Thesis.

Work is reported on periodic deviations from the Schottky line of a thorium-on-rhenium emitter. The surface reflection coefficient measured for a clean rhenium emitter of work function, 4.77 eV, and emission constant, 67, is $\mu = .29 \exp 0.75$. These thermionic emission fluctuations disappear abruptly for small thorium coverages (3% of a hypothetical monatomic layer). At about 50% monolayer coverage the periodic deviations return. Values of μ are recorded throughout this phenomenon. Compensation curves between the Richardson A and work function are obtained for thorium on rhenium and also for rhenium as a function of thermal processing history. The surface nonuniformities underlying these compensation effects are included in the periodic deviation analysis of Miller and Good. This extended model can explain the periodic deviations' washout phenomenon. Recourse to the intervention of many-body or crystallographic effects is not necessary. The Boeck micropatch model is evaluated to give a two-parameter description of the surface nonuniformities. (Diss. Abstr. Int., B)

13880 ROTATIONALLY INVARIANT THEORY FOR THE EFFECT OF MAGNETOELASTIC INTERACTIONS ON THE ELASTIC CONSTANTS OF THE HEAVY-RARE-EARTH METALS. Southern, B. W.; Goodings, D. A. (McMaster Univ., Hamilton, Ont.). Phys. Rev., B; 7: No. 1, 534-45(1 Jan 1973).

A theory developed by Toupin, Tiersten, Brown, and Melcher employing finite strains and angular-momentum invariants is applied to the rare-earth metals of hcp structure. A hamiltonian is written down which includes Heisenberg-exchange, crystal field, and magnetoelastic terms and is invariant under combined rotations of the magnetic and elastic systems. When the approximations of small-strain theory are subsequently carried out, there appear new terms originating in the crystal field that are linear in the antisymmetric strains $\omega_{\mu\nu}$ and correspond to rotations of the elastic medium. The coupling of transverse acoustic waves to the magnetic system is studied and expressions are derived for the dependence of the elastic constants c_{44} and c_{66} on an applied magnetic field in the ferromagnetic phase. The terms involving the antisymmetric strains result in new effects similar to those found by Melcher in MnF_2, from which it should be possible to obtain in a direct manner the values of certain magnetoelastic constants and anisotropy constants. Using available data on magnetic anisotropy and magnetostriction, the sizes are estimated of the effects that may be expected to be found in Gd, Tb, Dy, Ho, and Er. Fractional changes in c_{44} and c_{66} as large as 10^{-2} are predicted for Tb, Dy, Ho, and Er in a field of about 50 kOe, while the maximum change for Gd is predicted to be about 10^{-4}. Calculations are also performed for the field-dependent changes in c_{11} and c_{33} for longitudinal waves in the paramagnetic region. These changes result from the fact that the finite strains $E_{\mu\mu}$ include terms of the form $\epsilon^2_{\mu\mu}$. The resulting changes in c_{11} and c_{33} depend linearly on the magnetoelastic constants and vary as H^2 in the paramagnetic region. Estimates of certain combinations of these constants are made from the experimental measurements of Moran and Lüthi on Dy and Ho. (auth)

13881 EFFECT OF CRYSTAL FIELDS ON THE MAGNETIC PROPERTIES OF SAMARIUM INTERMETALLIC COMPOUNDS. de Wijn, H. W. (Rijksuniversiteit, Utrecht); van Diepen, A. M.; Buschow, K. H. J. Phys. Rev., B; 7: No. 1, 524-33(1 Jan 1973).

Neither of the intermetallics $SmAl_2$ (a ferromagnet below T_C = 120°K) and $SmSn_3$ (an antiferromagnet below T_N = 11°K) shows the sign reversal predicted by the White and Van Vleek for the 4f-induced Knight shift in the paramagnetic region. On the other hand, no particular anomaly has been observed in the temperature dependence of the susceptibility. An explanation for this is given in terms of mixing of excited J levels of Sm^{3+} into the $J = 5/2$ ground multiplet by cubic crystal fields. The calculation is described of the crystal field matrix elements of Sm^{3+} between any J and J′, and expressions are derived for the Knight shift and the susceptibility in the presence of crystalline and molecular fields. It is shown that the sixth-order component of the crystal field is important, and that the anomalous behavior is enhanced by ferromagnetic exchange between the Sm ions. A study of the lattice constants and the ^{27}Al quadrupolar coupling in comparison with other RAl_2 (R = rare earth) compounds excludes the possibility of Sm in $SmAl_2$ not being trivalent. (auth)

13882 LANDAU MODEL FOR THE CRITICAL SUSCEPTIBILITY OF A FERROMAGNET. Horn, P. M.; Bass, R.; Parks, R. D. (Univ. of Rochester, NY). Phys. Rev., B; 7: No. 1, 332-5(1 Jan 1973).

Measurements were made of the low-field magnetic susceptibility of the ferromagnet $GdNl_2$ in the reduced temperature interval $10^{-3} < \epsilon = (T - T_c)/T_c < 4$. The study focuses on the transition from Curie–Weiss behavior for $T \gg T_c$ to critical behavior for $T = T_c$. A phenomenological model based on Landau's theory of second-order phase transitions is presented which fits the experimental data in this interpolation region. The viability of a Landau model for predicting microscopic exchange interactions (from an analysis of the high-temperature susceptibility) is discussed critically. (auth)

13883 HEAT CAPACITY OF VANADIUM OXIDES AT LOW TEMPERATURE. McWhan, D. B. (Bell Telephone Labs., Murray Hill, N. J.); Remeika, J. P.; Maita, J. P.; (and others). Phys. Rev., B; 7: No. 1, 326-32(1 Jan 1973).

The electronic contribution to the heat capacity of $V_{1.97}O_3$, V_7O_{13}, and $V_{0.86}W_{0.14}O_2$ is very large, with $\gamma = (130 \pm 3)$, (80 ± 5), and $(80 \pm 5) \times 10^{-4}$ cal K^{-2} mole V, respectively. Comparison of effective masses calculated from the heat capacity, magnetic susceptibility, and optical properties suggests that the mass enhancement results mainly from spin fluctuations in a strongly correlated electron gas. The magnetic contribution to the entropy of V_4O_7 at 53°K is 0.32 cal K^{-1} mole V. (auth)

13884 MAGNETIC MOMENT, SUSCEPTIBILITY, AND ELECTRICAL RESISTIVITY OF DILUTE PARAMAGNETIC PALLADIUM–RARE-EARTH ALLOYS. Guertin, R. P. (Tufts Univ., Medford, MA); Praddaude, H. C.; Foner, S.; McNiff, E. J. Jr.; Barsoumian, B. Phys. Rev., B; 7: No. 1, 274-86(1 Jan 1973).

The magnetic properties and low-temperature electrical resistivity are reported for dilute alloys of the $Pd_{1-x}R_x$ system where R = Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, or Y, and x is generally 0.01 or less. Alloys with R = Ce, Gd, Dy, or Er are examined over a wide range of concentrations. The quantities measured were the magnetic susceptibility $\chi(T)$ for $4.2 \lesssim T \lesssim 250$°K, the magnetic moment $\sigma(H_0)$ for $T \lesssim 4.2$°K and for $H_0 \lesssim 210$ kG, and the residual electrical resistivity $\rho(T)$ at 4.2°K. Even at 200 kG, the rare-earth moments are not fully aligned with the applied field for $T \gtrsim 1.5$°K. The magnetic moment versus field data are analyzed in two ways: by a semi-empirical formula which includes a parameter that gives a convenient measure of ease of magnetic saturation of the rare-earth contribution and by crystal field theory. Based on the semi-empirical formula, the magnetic moment of the rare-earth ion is found to be close to its free-ion value, and the matrix susceptibility is also obtained. The application of the semi-empirical formula to both field-and temperature-dependent data is discussed extensively. From recent electron-paramagnetic-resonance data, crystal-field parameters for the $Pd_{1-x}Dy_x$ alloys are derived. Using these parameters, the field and temperature dependences of the magnetic moment for $Pd_{1-x}Dy_x$ are calculated. The best fit of crystal-field theory shows large systematic deviations from experiment, whereas the semi-empirical formula fits the observed data within experimental error for $H \gtrsim 3$ kG. The temperature-dependent susceptibility $\chi(T)$ is fitted to a Curie–Weiss law for the heavy rare-earth alloys and the free-ion value of the rare-earth moment is obtained within experimental error. The paramagnetic Curie temperature θ is less than ±3°K for $x \lesssim 0.01$. The $\chi(T)$ data for R = Y, Ce, Eu, or Lu (none of which has a measurable moment in Pd) show that the position and magnitude of the maximum of $\chi(T)$ (which occurs at ~85°K for pure Pd) are sensitive functions of R and x. The analysis of the residual electrical resistivity of $Pd_{1-x}R_x$ alloys for $x \sim 0.01$ shows that the Kasuya formula does not apply. Other scattering mechanisms are suggested and their predictions are compared with the magnetic properties. (auth)

13885 EVIDENCE FOR A SECOND MAGNETIC PHASE TRANSITION IN GADOLINIUM. Salamon, M. B.; Simons, D. S. (Univ. of Illinois, Urbana). Phys. Rev., B; 7: No. 1, 229-32(1 Jan 1973).

The heat capacity and temperature derivative of the electrical resistivity of Gd were measured simultaneously in the vicinity of 226°K, where the easy axis of magnetization tilts away from the crystallographic c axis. In addition to the known anomaly in the a-axis resistivity, a small step change in the specific heat was observed. Application of magnetic fields above 1000 Oe along the c axis or 120 Oe along the a axis suppressed both the resistive and specific-heat anomalies. This behavior is discussed in terms of a molecular-field model which treats the anisotropy energy as a term in the magnetic free energy. The tilting of the easy axis is driven by the temperature dependence of the magnetization, which causes the lowest-order anisotropy constant K_1 to change sign. The magnitudes of the step in the specific heat and the critical field in the c-axis direction calculated in this model are in good agreement with experiment. (auth)

13886 SURFACE-PLASMON EXCITATION IN SMALL SPHERICAL GRAPHITE PARTICLES BY X RAYS. Koumelis, C.; Leventouri, D. (Univ. of Athens). Phys. Rev., B; 7: No. 1, 181-4(1 Jan 1973).

X-ray scattering experiments were carried out on dried colloidal graphite, for scattering angles $\varphi = 0$ and 10°, using $CrK\beta_1$ line as a primary radiation. The spectrum for $\varphi = 0°$ shows a faint new component shifted by 13 ± 1 eV from the primary line; the same line was also found for a scattering angle $\varphi = 10°$. If the dried colloidal graphite was replaced by dried colloidal graphite embedded in gelatine, the new component moved to a position shifted by 10 ± 1 eV from the primary line. The corresponding experiments with polycrystalline graphite did not show such components. These new components can be attributed to a plasmon excitation on the spherical surface of each particle of colloidal graphite. This experiment shows that surface plasmons can be excited in small spherical particles independently of the scattering angle. (auth)

13887 ELECTRON-SPIN RESONANCE OF RARE EARTHS IN ALUMINUM. Rettori, C. (Univ. of California, Los Angeles); Davidov, D.; Orbach, R.; Chock, E. P.; Ricks, B. Phys. Rev., B; 7: No. 1, 1-7(1 Jan 1973).

The electron-spin resonance of Gd, Dy, and Er was observed in dilute Al-based alloys. From the temperature-dependent linewidth and the sign of the g shift, a value of the exchange integral $J_{f-s} = +0.11 \pm 0.02$ eV was extracted for Al:Dy and Al:Er. This value is in agreement with that extracted from the reduction of T_c in Al:Er, on the assumption of little influence of the crystalline field. The more concentrated Al:Gd alloys exhibited a strong magnetic-resonance bottleneck, which was partially opened by (i) reduction of the Gd concentration and (ii) by introducing a third element. The exchange integral was found to equal $J_{f-s} = +0.17 \pm 0.03$ eV for Al:Gd, and values were obtained for the spin–lattice relaxation rate of the conduction electrons from band effects, the Gd impurities themselves, and the third elements (Ag, Au). A "residual" positive g shift $\Delta g_1 = +0.05$ was noted for Al:Gd (as well as for a number of other dilute Gd alloys), and is tentatively attributed to polarization of the screening electrons of d-like character. (auth)

13888 TEMPERATURE-DEPENDENT HYPERFINE INTERACTIONS IN Fe_2B. Murphy, K. A.; Hershkowitz, N. (Univ. of Iowa, Iowa City). Phys. Rev., B; 7: No. 1, 23-31(1 Jan 1973).

Moessbauer absorption spectra were observed for Fe_2B from 290 to 1175°K. A change in the electric quadrupole interaction was observed from 460 to 480°K and interpreted as a result of the rotation of the easy axis of magnetization as a function of temperature. The effective magnetic hyperfine field as a function of temperature is found to be described by $(1 - T/T_C)^\beta$ in the range defined by $1.2 \times 10^{-3} \leq 1 - T/T_C \leq 7 \times 10^{-1}$ for $\beta = 0.32 \pm 0.01$. A discontinuity in the isomer shift of 0.018 ± 0.010 mm/sec was found across the ferromagnetic transition. (auth)

13889 RECENT DEVELOPMENTS IN MAGNETIC MATERIALS. Wernick, J. H. (Bell Telephone Labs., Inc., Murray Hill, NJ). Annu. Rev. Mater. Sci.; 2: 607-40(1972).

New rare earth-cobalt permanent magnet alloys and cylindrical domain materials are discussed in terms of the contrasting requirements for permanent magnets and for memory and logic devices. (169 references) (MHR)

13890 HYPERFINE FIELD OF ^{175}Lu IN Fe AND Ni AND ANNEALING PROPERTIES OF THE FeYb IMPLANTED ALLOY. Thome, L.; Benski, H. C.; Bernas, H. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 42A: No. 4, 327-8(18 Dec 1972).

Integral perturbed angular correlation measurements of the hyperfine field at ^{175}Lu isotope-separator implanted in Fe and Ni yield fields of −(575 ± 41) kOe and −(130 ± 27) kOe, respectively. A clear annealing stage is found around 450°C. (auth)

13891 MAGNETIC PROPERTIES AND ELECTRONIC STRUCTURE OF PLUTONIUM. Fournier, J. M. (CEN, Grenoble, France). J. Phys. (Paris); 33: No. 7, 699-706(Jul 1972). (In French).

A simple mechanism is proposed to explain the experimental results on the magnetic susceptibility of α-plutonium. A crude model of a band structure is suggested, which explains the other anomalous physical properties of α-plutonium (thermoelectric power, specific heat, Debye temperature, resistivity). (France)

13892 MAGNETIC PROPERTIES AND TEXTURE OF THIN STRIPS OF ALLOYS OF NICKEL–IRON–MOLYBDENUM. Borodkina, M. M.; Pesin, V. S.; Smirnova, L. G.; Sosnin, V. V.; Starostin, Yu. V. Fiz. Metal. Metalloved.; 33: No. 6, 1188-94(Jun 1972). (In Russian).

The magnetic properties (coercive force, induction) and texture of thin (5 and 2μ) strips of Ni–Fe–Mo alloys (75 to 87% Ni, 0 to 5.5% Mo) were investigated. The optimum cooling rate depended on the Ni and Mo contents and on the magnitude of the final compression during rolling. The optimum final compression increased with increased thickness. A preponderance of texture ⟨111⟩ or ⟨100⟩ was essential for α in the case of relatively thick strips (≥5 μ). Magneto-elastic effects lead to significant lowering of α. (tr-auth)

13893 MAGNETIC PROPERTIES OF COMPOUNDS OF IRON-GROUP TRANSITION METALS AND Vb, VIb ELEMENTS. Sato, K.; Adachi, K. (Nagoya Univ., Japan). Nippon Kinzoku Gakkai Kaiho; 11: No. 6, 447-67(Jun 1972). (In Japanese).

Data on magnetic properties of the compounds of iron-group transition metals (Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn) and VA, VIA elements (As, Sb, Bi, S, Se, Te) are summarized. Crystal structure, lattice constant, kind of magnetism, magnetic transition point, magnitude of magnetic moment and magnetic structure of these compounds are tabulated. Magnetic properties of a number of uranium compounds are also tabulated. (Japan)

13894 ELECTRICAL RESISTIVITY OF Gd–Th ALLOYS. Hennephof, J.; Leenstra, M. R. (Rijksuniversteit, Groningen, Netherlands). Physica; 62: No. 1, 155-60(1 Nov 1972).

Electrical-resistivity measurements were made over the 4.2 to 360°K temperature range on polycrystalline Gd_xTh_{1-x} samples with x varying from 0.10 to 0.99. In the region of the hexagonal structures (x = 0.99 to 0.60) the upper magnetic-ordering temperature decreases rapidly with increasing Th content. In the fcc region ($x \leq 0.50$) no indications of magnetic ordering could be detected. It was impossible to describe the results with the Dekker formulas for the electrical resistivity of binary heavy rare-earth alloys. (auth)

13895 ENERGY BAND STRUCTURE OF THE MONOCARBIDES OF Ti, Hg, AND Ta. Potorocha, V. I.; Tskhai, V. A.; Gel'd, P. V.; Kurmaev, E. Z. (Inst. of Chemistry, Moscow). Fiz. Metal. Metalloved.; 33: No. 5, 960-8(May 1972). (In Russian).

The energy spectra of electrons and the contribution of the atomic states to the formation of the zonal structure of TiC, HfC, and TaC were calculated by the strong bond method. A two-center approximation was used allowing for ns- and d-orbitals of metal atoms and the 2s-, 2p-orbitals of the carbon atom. The secular equation was solved at 214 points of 1/48 of the Brillouin zone. (tr-auth)

13896 SPIN CONFIGURATION AND INTRINSIC COERCIVE FIELD OF NARROW DOMAIN WALLS IN Co_5R COMPOUNDS. Hilzinger, H. R.; Kronmueller, H. (Max-Planck Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi (b); 54: No. 2, 593-604(1 Dec 1972).

In ferromagnetic materials with large anisotropy constants ($K_1 > 10^8$ erg/cm^3), the domain wall width, δ_B, is of the order of magnitude of a few lattice constants (10 to 30 Å). The spin configuration of such 180° walls in Co_5R compounds is determined within the framework of the Heisenberg model. It is found that the deviations from the micromagnetic solution occur mainly in the center of the wall. The wall energy was found to depend periodically on the position of the wall center with respect to the crystal lattice. The oscillations of the wall energy give rise to a coercive field $H_c = \text{const}\ (A/D)\ \exp[-\pi\delta_B/D]$ (A = exchange constant, D = wavelength perpendicular to the domain wall). Possibilities of obtaining large intrinsic coercive fields are discussed in some detail. (auth)

13897 THERMAL TRANSPORT IN EuO. Martin, J. J.; Dixon, G. S. (Oklahoma State Univ., Stillwater). Phys. Status Solidi (b); 54: No. 2, 707-12(1 Dec 1972).

The thermal conductivity of EuO was measured from 1 to 200°K with attention to effects of magnetic order. Near the Curie point, weak critical scattering was observed. At 1°K, the dominant heat carriers were found to be magnons. (auth)

13898 SPIN WAVES IN Ni–V ALLOY BY NEUTRON SCATTERING. Mikke, K.; Dobrzynski, L.; Jankowska, J. (Inst. of Nuclear Research, Swierk, Poland). Phys. Status Solidi (b); 54: No. 2, K99-101(1 Dec 1972).

Preliminary data are presented for the spin wave spectrum in $Ni_{0.97}V_{0.03}$ obtained by inelastic scattering of neutrons. The constant D in the dispersion relation $E = Dq^2$ is estimated to be 260 ± 20 meV Å^2. Some estimates are made for the ratio of the exchange integrals. (DLC)

13899 CRITICAL THICKNESS OF BERYLLIUM FILMS CONDENSED ON A COLD SUPPORT. Lazarev, B. G.; Kuz'menko, V. M.; Sudovtsov, A. I.; Mel'nikov, V. I. Fiz. Metal. Metalloved.; 33: No. 5, 984-9(May 1972). (In Russian).

The Hall effect was investigated as a function of the thickness of Be and Bi films which had been condensed on a base support which had been cooled to liquid helium temperature. The Hall

constant for Be showed a smooth transition from negative values (thinnest films) to positive values (thickest layers). In contrast, the Hall coefficient for freshly condensed layers of Bi was practically independent of layer thickness up to the critical, where a discontinuous increase in the Hall coefficient by two to three orders of magnitude occurred, corresponding to a phase transition change from amorphous to the crystalline state. It is suggested that the Be film consisted of a mixture of amorphous and crystalline phases beginning with a thickness of ~20 Å; the critical thickness for a Be layer was d ≤ 20 Å. (tr-auth)

13900 ELECTRICAL RESISTANCE OF BORIDES OF IRON, COBALT, AND NICKEL. Samsonov, G. V.; Kunitskii, Yu. A.; Kosenko, V. A. (Inst. of Problems in Material Studies, Kiev). Fiz. Metal. Metalloved.; 33: No. 4, 884-7(Apr 1972). (In Russian).

The temperature dependence of the electrical resistance of Fe, Co, and Ni borides was determined over the range of temperature 20 to 1,000°C. The T−R curves were very nearly linear for NiB, Ni_2B, and Ni_3B over this temperature range. The T−R curves for FeB, Fe_2B, Co_2B, Co_3B possessed pronounced points of inflection. That for CoB was only slight, but extrapolation of this curve to 0°K (similar to all the curves) emphasized the inherent inflecting trend. (KSW)

13901 ANOMALY IN THE ELECTRICAL RESISTANCE OF PRASEODYMIUM NEAR THE NEEL TEMPERATURE. Semenenko, E. E.; Tutov, V. I. (Physical-Technical Inst., Kiev). Fiz. Metal. Metalloved.; 33: No. 4, 879-80(Apr 1972). (In Russian).

The electrical resistances of samples of Pr of the following purities were measured between 6 and 35°K: 99.48% (0.020% Fe), 99.75% (0.035% Fe), and 99.90%. The slopes of the log resistance vs log temperature (°K) for all three samples did not remain constant over the range of temperature studied. This is interpreted in view of a transition of Pr from the para- to antiferromagnetic state, and aided in fixing the Néel temperature of Pr. (K.S.W.)

13902 STUDY OF ELECTRONIC STRUCTURE OF W–Re ALLOYS BY POSITRON ANNIHILATION. Budagovskii, S. S.; Bykov, V. N.; Gavrilyuk, M. I.; (and others) (Inst. of Metal Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 1, 28-33(Jan 1972). (In Russian).

Angular distributions of annihilation photons were measured in W−Re solid solutions in annealed and plastically deformed states. Anomalies of angular distribution characteristics were found with a rhenium concentration of 5 to 6 at. %. These anomalies are explained by the structure of core electron bands. Concentration dependence of the angular distribution curve in plastically deformed alloys is discussed on the basis of positron trapping by dislocations and perturbation centers. (auth)

13903 NATURE OF MAGNETOSTRICTION OF DYSPROSIUM AND OF ITS ALLOYS WITH GADOLINIUM. Levitin, R. Z.; Popov, Yu. F.; Chistyakov, O. D.; Yakovenko, V. L. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 16: No. 4, 158-61(20 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 4, 224-8(20 Aug 1972).

The magnetostriction of the alloys Dy_xGd_{1-x} ($0.046 \leq x \leq 1.0$) was measured in single crystals at 78 to 300°K. Longitudinal and transverse magnetostrictions were measured in an alloy with x = 0.296. The magnetostriction constants $\lambda\gamma,^2$ are plotted vs relative temperature and composition. Results are in agreement with the one-ion magnetostriction model. (D.L.C.)

13904 X-RAY EMISSION BAND INTENSITIES OF SOME 3d- AND 4d-METALS. Alperovich, G. I.; Nikiforov, I. Ya.; Gegusin, I. I. (Rostov State Univ., USSR). Phys. Status Solidi (b); 54: No. 2, K127-9(1 Dec 1972).

An attempt is made to see how far the x-ray emission band (XEB) intensities can be explained with band structure theory. The XEB considered are the K bands of 3d metals (V, Cr, Fe, Co, Ni, Cu) and L_3 and M_5 bands of 4d metals (Nb, Mo, Rh, Pd). The band structure was calculated by means of the Green function method. The calculated K-band intensities agree very well with experiment; for the L_3 and M_5 bands, there is a discrepancy by a constant factor of 2, probably due to the peculiarities of the internal process of x-ray excitation. (D.L.C.)

13905 SECONDARY EMISSION AND STRUCTURAL PROPERTIES OF SOLIDS. Arifov, U. A. (ed.). New York; Plenum Publishing Corporation (1971). 150p. $20.00.

Translation of Vtorichno-Emissionnye i Strukturnye Svoistva Tverdykh Tel by G. D. Archard.

Thirty-six papers are presented on: interactions of atomic particles with solid surfaces, atomic collisions involving multiply-charged ions, positron studies of matter, and structural research. Separate abstracts were prepared for 29 of the papers. (DLC)

For abstracts of individual papers see: 11647, 11718, 11957, 12467, 12543–12548, 12564, 12969–12983, 13005, 13166, and 13853.

13906 EFFECT OF HEAT TREATMENT ON THE ELECTRONIC STRUCTURE OF GLASS-LIKE B_2O_3 SYSTEMS. Bartenev, G. M.; Tsyganov, A. D.; Abrosimova, G. D. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 205: No. 2, 375-8(11 Jul 1972). (In Russian).

Samples of B_2O_3 were given various heat treatments at 230, 270, 310, and 350°C, and the pulsed distribution of electrons of the treated samples was studied to determine the positron annihilation involved with a standard apparatus having an angular resolution of 1 mrad and a positron source ^{22}Na. The count rate of coincident annihilated γ quanta was measured at room temperature. Thermomechanical curves were drawn showing distortion of B_2O_3 samples with various thermal histories. (KSW)

13907 DIRECTIONAL DEPENDENCE OF THE THERMAL CONDUCTIVITY OF CRYSTAL-ORIENTED PYROLYTIC GRAPHITE AT HIGH TEMPERATURES. Fridlender, B. A.; Neshpor, V. S. (Inst. of Applied Chemistry, Leningrad). High Temp. (USSR) (Engl. Transl.); 10: No. 2, 275-278(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 2, 313-317 (1972).

The vector effect of the thermal conductivity in a-form pyrolytic graphite was investigated by the phase method; the graphite had a density of 2.26 g/cm^3, was obtained by the chemical gas-phase condensation method at a temperature of 2400°C, and had a high degree of preferred orientation in the basal planes. The specimens were cut from a pyrolytic graphite plate about 12 mm thick, with various angles θ between the normal directions to the plane of the specimen and the condensation surface. The normal to the specimen surface coincides with the heat flow direction. The thickness of the specimens was about 0.045 to 0.120 mm. For purposes of comparison an investigation was made of a for the direction normal to the condensation surface of the pyrographite specimen that had been processed thermomechanically and had a more ideal texture. The dependence of the thermal conductivity of pyrolytic graphite on the temperature is calculated for the a and c directions. (auth)

13908 INFLUENCE OF PRESSURE ON THE HALL EFFECT IN RARE EARTH METALS. Vinokurova, L. I.; Kondorskii, E. I.; Ivanov, V. Yu.; Rakhimova, Kh. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 7, 1419-22(Jul 1972). (In Russian).

The effect of omnidirectional compression up to 12,000 kg/cm^2 on the Hall effect was studied in polycrystalline samples of Gd and Tb and in single crystals of Tb. At temperatures exceeding the temperature of magnetic ordering ($T > T_c$), the pressure did not change the linear dependence of the Hall emf on the magnetic field, and only decreased the absolute value of the effect. In the temperature realm of the ferromagnetic state ($T < T_c$), a small anomaly was observed in the Hall constant. (KSW)

13909 INVESTIGATION OF CRITICAL FIELDS IN DEPENDENCE ON THE PRESSURE AND TEMPERATURE IN RARE EARTH METALS AND ALLOYS WITH A HELICOIDAL MAGNETIC STRUCTURE. Nikitin, S. A.; Solntseva, L. I.; Suchkova, V. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 7, 1449-53(Jul 1972). (In Russian).

The temperature dependence of the critical field (H_{crit}) was determined for the metals Dy, Ho, and the two alloys Tb−31% Y and Tb−24% Y. The temperature dependence of the shift of H_{crit} on pressure was determined for Dy single crystals and for the alloys Tb−24% Y, Tb−16.6% Y, and Tb−9% Y. The temperature range covered in these studies was about 25 to 200°K. (KSW)

13910 MAGNETIC SCATTERING OF NEUTRONS IN MANY-DOMAIN FERROMAGNETS. Kurkin, M. I.; Tankeev, A. P.; Turov, E. A. (Inst. of Metal Physics, Moscow). Fiz. Metal. Metalloved.; 34: No. 2, 241-50(Aug 1972). (In Russian).

The peculiarities of elastic and inelastic neutron scattering associated with the presence of domain boundaries were investigated. The conditions of observation depended on the ratio between the dispersion of neutron wave vectors in the incident beam and the characteristic dimensions of the magnetic nonhomogeneity. (tr-auth)

13911 INFLUENCE OF PLASTIC DEFORMATION ON THE PARAMAGNETIC SUSCEPTIBILITY OF SINGLE CRYSTALS OF NIOBIUM. Deryagin, A. I.; Pavlov, V. A.; Vlasov, K. B. (Inst. of Metal Physics, Moscow). Fiz. Metal. Metalloved.; 34: No. 2, 279-82(Aug 1972). (In Russian).

The behavior of the magnetic susceptibility (χ) of single crystals

of Nb was studied after deforming the crystals by hydroextrusion. The value of χ was investigated at room temperature as functions of the intensity of the magnetic field (H), and of 1/H, for various degrees of deformation of the crystals from 30 to 70%. For the undeformed crystal of Nb, χ is independent of H. With increase in the degree of deformation, there was observed a rise in the susceptibility of the paraprocess, and the emergence of a nonlinear dependence of χ on H. (KSW)

13912 INTERZONE TRANSITIONS IN PENTAVALENT METALS WITH A BODY-CENTERED CUBIC LATTICE. Mash, I. D.; Motulevich, G. P. (Lebedev Int. of Physics, Moscow). Fiz. Metal. Metalloved.; 34: No. 2, 297-302(Aug 1972). (In Russian).

Frequencies and combination intensities of interzone transitions, associated with the intersection of Bragg planes, were investigated in pentavalent metals with a bcc lattice such as Nb and V. Parameters of the bands of interzonal conductivity and Fourier components of the pseudopotential of Nb and V were determined. The frequencies and intensities obtained were confirmed by experimental data. (KSW)

13913 ELECTRON TRANSFER AND ELECTRONIC PROPERTIES OF THE LIQUID METAL SYSTEMS CADMIUM–THALLIUM AND CADMIUM–INDIUM. Belashchenko, D. K.; Gushchina, E. I.; Pertsin, A. I. (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved.; 34: No. 2, 303-8(Aug 1972). (In Russian).

Electron transfer and electrical resistance were determined in the systems Cd–Tl and Cd–In at 350°C. From these data, the dependence of the function of the relative density of states at the Fermi level on composition was established. This behavior is discussed in terms of the variable valence of the Tl ion in metal solutions. It was considered highly probable that the charge on the Tl ion is three in all compositions. (tr-auth)

13914 SPIN-WAVE SPECTRUM IN DYSPROSIUM. Kalva, Z. (Inst. of Solid State Physics, Prague). Czech. J. Phys.; 22: No. 12, 1330-1331(1972).

Theoretical predictions of spin-wave energies in dysprosium are compared with experimental data. A diagram shows the comparison for energies from 1 to 5 MeV at 98°K. (MOW)

13915 NEW FORM OF WO_3. Schroeder, F. A. (Univ., Freiburg i. B.); Felser, H. Z. Kristallogr.; 135: No. 5/6, 391-398(Sep 1972). (In German).

Crystals of WO_3 were prepared by sublimation of 1450°C under flowing oxygen. The crystals are described and an unknown form development was found by optical measurements of crystallographic angles. Other optical and x-ray properties are described and discussed. (auth)

13916 POINT DEFECTS IN SOLIDS. VOLUME 1. GENERAL AND IONIC CRYSTALS. Crawford, J. H. Jr.; Slifkin, L. M. (eds.). New York; Plenum Publishing Corporation (1972). 566p. $37.50.

The eight chapters deal respectively with: statistical thermodynamics of point defects, ionic conductivity (including self-diffusion), defect mobilities in ionic crystals containing aliovalent ions, defect creation by radiation in polar crystals, electron centers, hole centers in halide lattices, color centers in simple oxides, and conduction by polarons in ionic crystals. A separate abstract was prepared for the fourth chapter. (DLC)

For an abstract of an individual chapter see: 13862.

13917 THERMAL CONDUCTIVITY AND LORENZ NUMBER OF HIGH-PURITY PRASEODYMIUM. Tee, K. T.; Meaden, G. T. (Dalhousie Univ., Halifax, Can.). J. Low Temp. Phys.; 9: No. 5-6, 447-56(Dec 1972).

Thermal conductivity and Lorenz number measurements are reported for praseodymium over the temperature range 2 to 40°K. The measurements made on a well-annealed dhcp polycrystalline specimen reveal behavior which is more typical of free-electron-like metals than of rare-earth metals. However, before the specimen was adequately annealed, the Lorenz numbers were abnormally high in a manner that resembled those published for many other rare earths. (28 references) (auth)

13918 ELASTIC CONSTANTS OF HOLMIUM BETWEEN 78 AND 300 K. Salama, K.; Brotzen, F. R.; Donoho, P. L. (Rice Univ., Houston, TX). J. Appl. Phys.; 44: No. 1, 180-3(Jan 1973).

The adiabatic elastic constants of holmium were determined in the temperature range from 78 to 300°K, using high-purity single crystals. The constants were obtained from the ultrasonic-wave velocities (20 MHz) measured by the pulse-superposition method. The values of the constants at room temperature in units of 10^{11} dyn/cm^2 are $c_{33} = 8.015$, $c_{44} = 2.592$, $c_{11} = 7.612$, $c_{12} = 2.600$, and $c_{13} = 2.072$. Using these values, the Debye temperature was computed to be 181°K. The sound velocities tend to vary with temperature in an anomalous fashion near the Néel temperature (T_N = 131°K). Attenuation and sound-velocity measurements near T_N permit an estimate of the relaxation time for spin fluctuations, which was found to be 3×10^{-10} s. (auth)

13919 ACTIVATIONLESS HOPPING CONDUCTIVITY IN COMPENSATED GERMANIUM. Ionov, A. N.; Shlimak, I. S. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 16: No. 7, 264-6(5 Oct 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 7, 374-7(5 Oct 1972).

The experiments were performed under conditions such that the current was independent of the pulse duration and of the off-duty cycle. Diagrams show the temperature dependences of the conductivity on the samples in different fields. At the very lowest temperatures, one can see clearly the effect of the activationless hopping conductivity, where the conductivity ceases to depend on the temperature and depends only on the applied field. (MOW)

Moessbauer Effects and NMR

Refer also to abstracts 12142 and 12154.

13920 MAGNETIC ANISOTROPY AND CONDUCTION-ELECTRON EXCHANGE POLARIZATION IN FERROMAGNETIC (RARE-EARTH)Al_2 COMPOUNDS. Kaplan, N. (Technische Hochschule, Darmstadt, Ger.); Dormann, E.; Buschow, K. H. J.; Lebenbaum, D. Phys. Rev., B; 7: No. 1, 40-9(1 Jan 1973).

^{27}Al NMR in ferromagnetic RAl_2 (R = Pr, Nd, Sm, Gd, Tb, Dy, Ho) was studied. The easy direction of magnetization was observed experimentally for the first time and a theoretical calculation, in accord with the observation, was developed. The s–f exchange parameters were examined and in addition to the isotropic exchange parameter Γ_{sf}, the existence of a small but significant anisotropic s–f exchange term is verified experimentally for the first time. The accurately determined (±1%) isotropic exchange parameters are compared with theoretical predictions. (auth)

13921 NATURE OF ANOMALOUS DEPENDENCE OF SPIN–LATTICE RELAXATION VELOCITY ON THE MAGNETIC FIELD IN NEUTRON-IRRADIATED QUARTZ. Smirnova, T. A.; Shamfarov, Ya. L. (Inst. of Radiophysics and Electronics, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 298-301(Feb 1972). (In Russian).

The saturation nature of the EPR line in a neutron-irradiated single crystal of quartz was studied at 4.2°K and frequency of 9 and 37 GHz. It is shown that the observed decrease in this crystal of the spin-relaxation velocity with an increase in a static magnetic field at low temperatures may be explained by the presence of the cross relaxation between two spin systems. The EPR lines of these systems are more overlapped the weaker the magnetic field. (auth)

13922 NUCLEAR MAGNETIC RESONANCE IN TERNARY ALLOYS OF VANADIUM–GERMANIUM–ALUMINUM. Zhuzhgov, V. M.; Pryadein, V. I.; Surikov, V. I.; Stepanov, A. P.; Aleksashin, B. A. (Inst. of Metal Physics, Moscow). Fiz. Metal. Metalloved.; 33: No. 5, 1093-5(May 1972). (In Russian).

The Knight shift in NMR spectra of ^{51}V was measured in the solid solutions $(V_{3.14}Ge)_{1-x}(V_3Al)_x$ where x = 0, 0.07, 0.15, 0.30, 0.50, 0.70, and 0.85 molar parts. The temperature range of the NMR measurements was from −175 to +20°C. The concentration dependence of the shift is plotted, and the susceptibility is displayed as a function of the mole % V_3Al. (K.S.W.)

13923 NUCLEAR MAGNETIC RESONANCE STUDY OF Co_2B. Kasaya, M.; Hihara, T.; Koi, Y. (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 34: No. 1, 63-7(Jan 1973).

Measurements of hyperfine field and quadrupole coupling of ^{59}Co were made on the intermetallic compound Co_2B. A large anisotropy in the hyperfine field is observed. The hyperfine fields along the local orthorhombic axes (x, y, and z) of the Co sites are −53.7, −83.1, and −123.6 kOe, respectively, where the z axis is the two-fold axis which lies along the tetragonal ⟨110⟩ direction. The electric field gradients, $|q_{xx}|$, $q_{yy}|$, and $|q_{zz}|$, are 1.43×10^{24}, 0.08×10^{24}, and 1.47×10^{24} cm^{-3}, respectively. The charge distribution compatible with the observed electric field gradients suggests that the electronic states near the top of the band have a character of $\psi = \alpha(3z^2 - r^2) + \beta(x^2 - y^2)$. (auth)

13924 MOESSBAUER THERMOMETER USING ^{119}Sn NUCLEI IN THE MILLIDEGREE REGION. Pavlov, D. V.; Parshin, A. Ya.; Peshkov, V. P.; (and others) (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 4, 163-4 (20 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 4, 231-3(20 Aug 1972).

^{119}Sn atoms were introduced into iron in order to measure the Moessbauer temperatures of ^{119}Sn and ^{57}Fe simultaneously. The logarithm (ln p) of the intensity ratio of the symmetrical absorption lines was measured. At low powers, the temperature dependence of ln p does not deviate from the Boltzmann formula $\ln p \propto \Delta/T$. The deviations for ^{57}Fe cannot be attributed to simple superheating. Results indicate that ^{119}Sn in an iron matrix can be used to measure temperatures to 6×10^{-3} °K, and that the hyperfine levels of ^{57}Fe are not in thermal equilibrium below 0.015°K. (D.L.C.)

13925 ESR OF Gd^{3+} IN CALCIA-STABILIZED ZIRCONIA. Bacquet, G.; Dugas, J.; Escribe, C.; Fabre, F. (Univ. Paul Sabatier, Toulouse). Phys. Status Solidi (b); 54: No. 2, K107-9 (1 Dec 1972).

Room-temperature ESR spectra are measured for single crystals of calcia-stabilized zirconia (14% CaO) containing 1000 ppM Gd_2O_3. With the magnetic field parallel to [100], the spectrum contained ten lines with a linewidth of 20 to 50 G. With the field parallel to [111], only three broad lines are seen. The patterns are interpreted as being due to Gd^{3+} in cubic Zr^{4+} substitutional sites, with a weak rhombic field along [100]. For each defect, the other two principal axes of the strain are directed along the two [110] directions included in the (100) plane. The superposition of parallel and perpendicular spectra is observed. Spin-Hamiltonian parameters are given for the field parallel to [100]. (D.L.C.)

13926 CALCULATION OF THE MOESSBAUER FRACTION. Morariu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 8, 991-1012(1972). (In Rumanian).

Sections are devoted to calculation of the Moessbauer fraction, f,:. (1) in the general case, (2) in a real crystal, and (3) expressions for physical values by the Einstein and Debye models. (auth)

13927 DETERMINATION OF THE RECOILLESS FRACTION OF MOESSBAUER ABSORBERS. O'Conner, D. A.; Skyrme, G. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 106: No. 1, 77-81(1973).

The method described for determining the area of a Moessbauer absorber line depends on experimentally integrating the transmitted intensity as the source is scanned across the line. The measurement does not depend on the source line shape. The interpretation of the absorbed line area in terms of the absorber recoilless fraction is discussed, and a method is presented for obtaining the characteristic temperatures $\theta(-2)$ and $\theta(-1)$ from the area measurements that does not involve a knowledge of the nuclear cross section. (auth)

13928 TEMPERATURE OF SPIN–SPIN INTERACTIONS IN ELECTRON PARAMAGNETIC RESONANCE. Atsarkin, V. A.; Rodak, M. I. (Inst. of Radio Tech. and Electronics, Moscow). Usp. Fiz. Nauk; 107: No. 1, 3-27(May 1972). (In Russian).

The dynamic behavior of spin systems in solids is currently being studied by a method based on the release of the energy of the relatively weak spin–spin interactions into separate "reservoirs" with a specific temperature, T_{ss}. Development of the spin–spin reservoir concept helped to predict unexpected physical effects, involving saturation of the magnetic resonance lines, transfer of excitation in the spectrum, and electron–nuclear spin–spin interactions. In the traditional paramagnetic resonance theory, it is assumed that the probability of the location of a spin system at its energy level is determined by the canonical distribution. The derived equations may be considered as representing the Boltzmann distribution of the population in a simple 2-level scheme, corresponding to the individual spin spectrum. Using the population concept, the behavior of spin systems may be described by simple velocity equations related to paramagnetic resonance. The methods used to measure the spin–spin temperature and the shape of the electron paramagnetic resonance under saturation conditions are described, examining also new aspects of cross-relaxation and the nonuniform line widening. (TTT)

PHYSICS (THEORETICAL)

Refer also to abstract 12991.

13929 LOCAL AND ASYMPTOTICAL STRUCTURE OF QUANTUM SYSTEMS WITH SUPERSELECTION RULES. Sushko, V. N.; Khoruzhii, S. S. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 13: No. 3, 291-312(Dec 1972). (In Russian).

On the basis of a general algebraic description of a quantum system with superselection rules, developed earlier, an investigation is made of the local and asymptotical structure of such systems. The essential part of the investigation consists in the study of the equivalence properties of coherent superselection sectors. It is proved that the physical (weak) equivalence of coherent sectors is independent of the Haag–Araki postulates and is equivalent to simplicity of a quasilocal algebra, to the extended locality condition and to the globality of superselection operators. The structure of ideals of the quasilocal algebra is completely described. The "asymptotical condition" is introduced which ensures asymptotical unitary equivalence of coherent sectors as well as vacuum-like asymptotical behavior of states under space-like translations. (auth)

13930 DISCRETE SPECTRUM OF THE SCHROEDINGER THREE-PARTICLE OPERATOR. Yafaev, D. R. (Leningrad State Univ.). Dokl. Akad. Nauk SSSR; 206: No. 1, 68-70(1 Sep 1972). (In Russian).

A new method of investigation was applied to the problem of scattering for the Schroedinger operator of a system of three mutually-interacting particles previously studied by L. D. Fadeev (1963). In this problem the particle interaction was characterized by a Coulombic feature. The spectrum of a hydrogen ion did not have a null accumulation limit point. The result was a confirmation of earlier physicists relative to the discrete spectrum of a negative hydrogen ion. (KSW)

13931 QUANTAL TREATMENT OF THE DOUBLE-WELL POTENTIAL PROBLEM BY MEANS OF CERTAIN PHASE-INTEGRAL APPROXIMATIONS. Froeman, N.; Froeman, P. O.; Myhrman, U.; Paulsson, R. (Uppsala Univ.). Ann. Phys. (N. Y.); 74: No. 2, 314-23(Dec 1972).

In the formulas given in the previous papers by Froeman and by Froeman and Myhrman on the eigenvalue problem of the double oscillator, a certain quantity σ occurs, which is negligible for energies lying far from the top of the barrier but which is important for energy levels in the immediate neighborhood of the top of the barrier. For the higher-order phase-integral approximations the quantity σ, in fact, cancels a singularity appearing in certain contour integrals when the energy approaches the top of the barrier. The numerical results reported in the papers mentioned were obtained disregarding σ, since convenient approximate expressions for σ, pertaining to the higher-order phase-integral approximations used, were not known when the papers were published. As a consequence, the energy levels in the immediate neighborhood of the top of the barrier were not good. This deficiency is now remedied, and the purpose of the present paper is to give definitive formulas obtained by the quantal treatment of the energy eigenvalue problem of the double oscillator by means of the phase-integral approximations in question, up to the fifth order. The great accuracy of these formulas, also for energies close to the top of the barrier, is illustrated numerically. (1 figure, 3 tables) (auth)

13932 RELATIVISTIC CLASSICAL MECHANICS OF A NON-LOCALIZABLE SPINNING PARTICLE. Wieland, M. S. Newark, DE; Univ. of Delaware (1972). 145p. University Microfilms Order No. 72-32,027.

Thesis.

The relativistic classical mechanics of a non-localizable spinning particle results in a quantitative theory of zitterbewegung. The center of inertia (inertial coordinate) locates the particle's point mass, while a different coordinate, the canonical coordinate, locates the particle's point charge; for this reason the particle is referred to as non-localizable. The relationship between the inertial and canonical representations (coordinates plus corresponding spin tensors) is discussed. It is demonstrated that the Poisson brackets of the inertial representation yield a set of Poisson brackets for the canonical representation. The canonical Poisson bracket relations resemble their quantum mechanical counterparts, the commutation relations. The canonical coordinate transforms properly under Lorentz transformations, and is a canonically conjugate coordinate; this result follows from the additional degrees of freedom inherent in the canonical representation. The equations of motion are formulated in a reasonable but intuitive way; the inertial world-line displacement parametrizes the motion. The hypothesis of the theory includes a number of restrictions. The rest mass of the particle, which is defined in the usual way, is not necessarily conserved. A constant characteristic mass m which is not necessarily equal to the rest mass is defined. The last restriction imposed requires that all reference frame observers measure c for the instantaneous speed of the charge. For non-zero rest masses the motion of the charge is roughly helical rather than rectilinear. The formulation yields a uniquely different definition for the characteristic spin of the particle; the characteristic spin is a relativistic invariant and conserved. The inertial world-line requirement (our choice of parametrization) yields the results that the rest mass is equal to the characteristic mass, and that the canonical spin in the rest frame is equal to characteristic spin, when there is no interaction; these results determine the numerical values of the conserved relativistic invariants. The zitter-radius or four-separation between the inertial and canonical coordinates is a ratio of fundamental constants in our theory; unlike like other zitter-theories, our zitter-radius is not unbounded and not undetermined. The same remarks hold for the zitter-rate (zitter-frequency). The formulation is extended into the interaction region. From a full quadratic equation for the square of the rest mass, a critical field strength is obtained which is roughly the critical field strength in quantum electrodynamics. From a weak field approximation a result is obtained which resembles the operator equation in Dirac's theory. The energy levels obtained for the particle interacting with a constant magnetic field are comparable to the results from Dirac's theory. The hypotheses of the radiation theories of Dirac and Rohrlich are incompatible with our formulation. Following the technique of Rohrlich and using the restrictions implied by our formulation, the radiation field tensor is rederived which corresponds to the theory. The radiation field tensor which results is finite. Unlike the results of Dirac and Rohrlich, the result contains a residual undetermined unit four-vector. (Diss. Abstr. Int., B)

13933 QUANTUM MEASUREMENT PROCESSES. Emch, G. G. (Univ. of Rochester, NY). Helv. Phys. Acta; 45: 1049-1056(1972).

A modification of von Neumann's theory of the measurement process is presented avoiding certain objections raised against the latter. It is shown that the considerations are nonvacuous by constructing explicitly a mathematical model satisfying the conditions put forward. (auth)

13934 SPECTRAL PROPERTIES OF SOME ONE-PARTICLE SCHROEDINGER HAMILTONIANS. Thomas, L. E. (Forschungsinstitut fuer Mathematik, Zurich). Helv. Phys. Acta; 45: 1057-1065(1972).

A class of relatively compact perturbations $\{V\}$ of $H_0 = p_1^2 + p_2^2 + p_3^2$ acting in momentum space, $L^2(R^3, d^3p)$ is considered. Resolvent matrix elements $[\phi(1/H_0 + V - z)\phi]$ are shown to be meromorphic in a neighborhood of the positive real axis, ϕ belonging to a dense set. Absolute continuity of the continuous spectrum follows. (auth)

13935 SINGLE-VALUED AND MULTI-VALUED SCHROEDINGER WAVE FUNCTIONS. Reiss, J. (College de France, Paris). Helv. Phys. Acta; 45: 1066-1073(1972).

The question of whether wave functions are always single-valued in nonrelativistic quantum mechanics is re-examined. It is found that a general proof of the single-valuedness has so far been given only for cases of high spatial symmetry. (In particular it is shown that the derivations of the single-valuedness for wave functions describing an Aharonov–Bohm effect appearing in the literature are unsatisfactory.) It is proven that the majority of nonrelativistic, time-independent wave functions are in fact either single-valued, or multi-valued in such a way that they are unitarily equivalent to single-valued functions. This result is a direct consequence of the ellipticity of the Schroedinger equation and of the simply-connectedness of the three-dimensional Euclidian space. Therefore no special postulate is required to guarantee the single-valuedness of nonrelativistic wave functions. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 14246 and 14325.

13936 (BMBW-FBK-72-16) DEVELOPMENT OF A 300 MWe PROTOTYPE NUCLEAR POWER STATION WITH SODIUM COOLED FAST REACTOR SNR. Final Report. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany). Siemens A.G.; Erlangen (West Germany)). Sep 1972. 303p. (In German). Dep. NTIS (U. S. Sales Only).

The contract placed on November 9, 1966, by the German Federal Ministry for Education and Science with the Consortium SIEMENS-INTERATOM, calling for the development and design of a 300 MW(e) prototype nuclear power station incorporating a Sodium cooled Fast Reactor (SNR), was performed and completed by the submittal of the pertinent Bid Proposal Documents on December 31, 1969. A summarized description of the activities carried out is presented. Also outlined are the reasons for adopting the solutions inherent in the concept selected, the alternative approaches investigated, and the computer programs prepared mainly in the work areas of physics, safety, and dynamic analyses. Furthermore, the essential results are reported of the experimental program in the course of which four large-scale sodium test facilities were planned and built, and numerous tests were performed mainly in the field of sodium technology. (auth)

13937 (NP-19476, pp 105-11) RESEARCH COORDINATION AT FINNATOM. Graae, T. (FINNATOM, Helsinki). 7 Mar 1972. (In Finnish).

Finnatom's activities fall into four categories: sales, system planning, projects, and research. In all these Finnatom's part is generally coordination. In product research there are three project forms, (a) research carried out and paid for by the member firm, (b) research carried out by Finnatom and one member firm, and (c) research carried out by several concerns and Finnatom together. Form (b) is the most usual. Research projects in progress include a test station for primary circuit components for PWRs, a treatment system for radioactive waste, a ventilation system for radioactive rooms, etc. More fundamental technical research is being carried out on thick-walled pressure vessels and welded cladding methods for nuclear power plant components. (Norway)

13938 FUTURE PROSPECTS FOR THE THTR POWER STATION. Schulten, R. (Kernforschungsanlage, Juelich, Ger.). Mitt. Ver. Grosskesselbetr.; 50: No. 6, 500-4(Dec 1970). (In German).

The development of high temperature reactors in West Germany has shown that operations involving continuous loading with spherical fuel elements is practical. It has also shown that the high temperature reactors possess significant advantages over light water reactors with respect to cooling water demands, thermal efficiency, and uranium utilization. The THTR reactor also has superior qualities from a safety standpoint. Application of the system extends not only to electricity production but also to heat utilization for gasification of coal and other branches of the chemical industry. (H.B.G.)

13939 ROLE OF ATOMIC POWER IN THE DEVELOPMENT OF THE USSR POWER ENGINEERING. Margulova, T. Kh. (Moscow Inst. of Energy). Izv. Vyssh. Ucheb. Zaved., Energ.; No. 12, 48-50(1971). (In Russian).

On the basis of published material and the Letters of Instructions from the XXIV Congress of the KPSS, an analysis is presented of the USSR power development during the past year and of the nuclear power development in the world and in the USSR both for the preceding year and in the current year. Indications are that the future years will be a period of intensive development of atomic power stations. (tr-auth) (INIS)

13940 ELEMENTS OF NUCLEAR POWER. Bennet, D. J. London; Longman (1972). 207p.

Short statements are given on atomic and nuclear physics, neutrons and their interaction with matter, and the chain reaction and principles of nuclear reactors. The subject is then developed in detail under the following headings: theory of nuclear reactors (reactor models, infinite homogeneous reactor, continuous slowing-down model and resonance escape probability, fast fission factor, infinite reproduction constant, finite homogeneous reactors, one-group neutron diffusion theory, neutron diffusion equation, diffusion length, neutron diffusion in multiplying media—the reactor equation, neutron leakage, form factors, two-group theory for bare reactors, Fermi age theory, heterogeneous reactors, fuel utilization factor, thermal utilization factor, resonance escape probability, fast fission factor, diffusion and slowing-down lengths, reflected reactors, one-group theory of reflected reactors); heat transfer and fluid flow (heat conduction in fuel elements, plate type fuel element, cylindrical fuel element, convective heat transfer from the fuel element to the coolant, the choice of coolants for reactors, coolant flow through a reactor core—pressure drop and pumping power); thermodynamic aspects of nuclear power plant (heat exchangers and steam cycles for gas-cooled reactors, further advances in gas-cooled reactors, pressurized water reactors, boiling water reactors, heavy water reactors, fast reactors); operating characteristics (reactor kinetics, delayed neutrons, reactivity changes in an operating reactor, reactor poisons, temperature effects on reactivity, control systems in reactors); radiation hazards and shielding (health physics, interaction of gamma radiation and matter, shielding of sources of gamma radiation, reactor shielding, shield heating). (UK)

13941 STATUS REPORT OF THE FAST-BREEDER PROJECT IN MOL. Hueper, R. KFK Nachr.; 4: No. 2, 37-40(1972). (In German).

A status report is presented on: international cooperative efforts to develop the SNR; preparatory work on the SNR-300; contributions to this project by the various European research centers; special problems associated with FBR-type reactors; and plans for developing fast-breeder reactors. (GF)

13942 DEVELOPMENT OF NUCLEAR ACTIVITIES AT FIAT. Businaro, U. L. (FIAT, Turin). Energ. Nucl. (Milan); 19: No. 8-9, 544-59(1972). (In Italian).

The experience and capacity achieved by FIAT in the nuclear field are described. The framework of the nuclear activity is outlined. The long-term objectives in the nuclear field include the creation of a technological capacity for building and operating nuclear power stations, the development of nuclear naval propulsion technology, the development of capacity for producing key components for nuclear reactors, and acquisition of advanced reactor technology. The degree of achievement of each of these objectives is discussed. (J.S.R.)

13943 BREEDER REACTOR STATUS REPORT 1972. Wiss., Wirt., Polit.; 2: No. 13, 2(1972). (In German).

The status of the SNR reactor in 1972 is described briefly. (G.F.)

Physics and Core Engineering

Refer also to abstract 12002.

13944 (ANL-7720) ARC SYSTEM TWO-DIMENSIONAL ADJUNCT CALCULATIONS. Daly, T. A.; Stenberg, C. G.; Neal, D. E.; Schoengold, D. A.; Leaf, G. K. (Argonne National Lab., Ill.). Oct 1972. Contract W-31-109-eng-38. 479p. Dep. NTIS.

A description is presented of the ARC System modules AJC004 and AJC002, which perform two-dimensional adjunct computations in terms of flux, geometry, boundary, and cross-section data provided. The module AJC004 provides first-order diffusion-perturbation theory estimates of $\delta k/k^2$ for changes in cross-section data, in composition-region assignments, and in the reactor half-height. On user option delayed neutron fractions, β-eff, and a reactivity table may also be computed. The module AJC002 produces a neutron inventory of the various source and reaction rates for all isotopes and specified materials and compositions. Leakage rates, breeding and conversion ratios, and reaction rates for specified foils may also be obtained. (auth)

13945 (CONF-721112-4) COMPARISONS OF HIGH-TEMPERATURE STRUCTURAL TEST RESULTS WITH INELASTIC ANALYSIS PREDICTIONS BASED ON INTERIM CONSTITUTIVE EQUATIONS FOR LIQUID-METAL FAST BREEDER REACTOR SYSTEM COMPONENTS. Corum, J. M. (Oak Ridge National Lab., Tenn.). 1972. Contract W-7405-eng-26. 32p. Dep. NTIS.

From American Society of Mechanical Engineers Winter Meeting; New York, NY (26 Nov 1972).

13946 (EURFNR-1019) ANISOTROPIC DIFFUSION IN GAS-COOLED FAST BREEDER REACTORS. Eisemann, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar 1972. 146p. (KFK-1577). Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The calculation of anisotropic diffusion effects (streaming effects) in gas cooled fast reactor lattices is described. For this purpose, expressions have been derived for the components of a homogenized direction dependent cell diffusion coefficient. This was done in a multigroup formalism taking into account the anisotropy of the elastic scattering cross sections up to the first moment. In addition, expressions for the components of the direction dependent diffusion coefficient have been developed which can be evaluated numerically. To demonstrate the influence of this diffusion coefficient calculations have been performed to determine the effective multiplication factor and the criticality change due to coolant variations for certain reactor concepts. 33 references. (auth)

13947 (KR-147) RAMONA II: A FORTRAN CODE FOR TRANSIENT ANALYSIS OF BOILING WATER REACTORS. Holt, R.; Rasmussen, J. (Institutt for Atomenergi, Kjeller (Norway)). Aug 1972. 155p. Dep. NTIS (U. S. Sales Only).

The BWR dynamics code RAMONA II is described. RAMONA II uses the two-group diffusion model with space-dependence in one dimension. The user's manual and the description of the test cases are included. (18 references) (auth)

13948 (LTH-IR-7207) MAXIMUM LIKELIHOOD IDENTIFICATION OF SOME LOOPS OF THE HALDEN BOILING WATER REACTOR. Olsson, Gustaf (Lund Inst. of Tech. (Sweden). Div. of Automatic Control). Mar 1972. 125p. Dep. NTIS (U. S. Sales Only).

The dynamics of some loops of the Halden Boiling Water Reactor were identified with the Maximum Likelihood method. Rod reactivity, subcooling flow and steam flow demand were used as inputs, while the two most important outputs are nuclear power and primary pressure. The model order never exceeded four. The achieved models are compared partly between different experiments, partly with a state model developed in Halden. The choice of input signal is shown to be crucial as the reactor time constants cover a broad range. (30 references) (auth)

13949 (ORNL-4812) DEVELOPMENT STATUS OF MOLTEN-SALT BREEDER REACTORS. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 416p. Dep. NTIS.

Molten-salt reactor technology, under development since 1947, has led to a concept of a high-temperature, thermal-neutron breeder reactor that operates on the thorium-^{233}U fuel cycle. A connected processing plant that continuously removes protactinium and fission products from the fuel salt is a basic feature of the system. The success of the Molten-Salt Reactor Experiment that was operated between 1965 and 1969, the development of a new processing method that allowed simplification of the breeder design, and the potential breeding performance, economics, and safety of the concept, are cited as arguments for the continued development of MSBR's. The status of the technology, further development needs for an MSBR, and the program staff's assessments of the uncertainties and the likelihood of success are presented. Separate chapters are devoted to reactor physics, chemistry, graphite, reactor metals, reactor components and systems, cells and building, control and instrumentation, fuel processing, maintenance, design studies, and environmental effects and safety. (auth)

13950 (ORNL-TM-3963) ZERO-POWER EXPERIMENTS WITH ^{233}U IN THE MSRE. Engel, J. R.; Prince, B. E. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 60p. Dep. NTIS.

Zero-power nuclear tests were performed in the MSRE with ^{233}U as the principal fissile isotope in October and November 1968. The initial critical loading was 1.9 ± 1% lower than the corresponding calculated value while the measured control-rod worths, the fuel concentration coefficient, and the temperature coefficient of reactivity were all within 7% of their predicted values. Dynamics tests indicated good nuclear stability and demonstrated the adequacy of the predictions and testing techniques. Neutron noise associated with circulating gas bubbles prevented measurement of the effective delayed neutron fraction with circulating fuel. Uncertainties in the precise condition of the reactor, as a consequence of prior operation with ^{235}U fuel, and a strong dependence of the neutronics calculations on the treatment of neutron leakage prevented any refinement of the basic nuclear data for ^{233}U from the experimental results. (auth)

13951 MEANS FOR SUPPORTING FISSILE MATERIAL IN A NUCLEAR REACTOR. Fortescue, P.; Shanstrom, R. T. (to Gulf Oil Corp.). U. S. Patent 3,703,437. 21 Nov 1972. Filed 20 Aug 1969.

A power fast reactor system is described which utilizes gas as a coolant. The reactor system includes a prestressed concrete containment vessel which contains the entire primary system of the reactor, comprising the core, control rod drive mechanisms, coolant circulators, steam generators, and associated main coolant ducting. The interior of the vessel is separated into two regions, the lower one containing the core and having provision for explosion absorption and water flooding. The core is comprised of fuel elements supported in a plurality of elongated tubes which depend freely from a generally horizontal grid structure. The tubes are secured in the grid structure and mate therewith at their upper ends. (Official Gazette)

13952 CORE DESIGN FOR HTR. Hart, J. D. pp 275-92 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant: London, England (3 May 1972). See CONF-720549.

An outline is given of design evolution for the High Temperature Reactor, followed by a discussion of core design problems and fuel pin design. In reviewing the problems of core design the viability of the HTR concept remains intact, but continuing changes of detail can be expected to improve its economics. (UK)

13953 CORE DESIGN FOR HIGH TEMPERATURE REACTORS. Felten, P.; Patarin, L. pp 293-313 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant: London, England (3 May 1972). See CONF-720549.

The problems set by the core design of High Temperature Reactors are discussed under the following headings: design problems (joining up of core blocks; leak tightness of core stack; support structures and lateral holding; shielding; refueling; and power, temperature, and fission product control-orificing system). Operating problems discussed include: irradiation-induced deformations of blocks; stack column instability; stack leaks; refueling operations; failure of coolant; channel blockage; fall of block during refueling; and earthquakes). Investigated solutions to these problems are also discussed. Further development work is also indicated. It is stated that the essential problem in HTR core design is assembling difficulties for the graphite blocks, taking into account their periodic removal, and radiation-induced dimensional changes of graphite greatly increase these difficulties and may produce coolant flow bypasses. The paper is based essentially on work in France. (UK)

13954 TEMPERATURE CALCULATION IN THE THTR-CORE. Pagenkaemper, J. Aachen; Technische Hochschule (1970). 122p. (In German).

Thesis.

The basic design of the reactor core is outlined and the properties of statistically packed spheres and methods and results of the calculation of the gas flow in the pebble-bed core and of the temperature distribution inside of a fuel sphere are discussed. The calculation programs BLACK JACK and HOT DOG are described and tests on the turbulent thermal conductivity of gases in randomly packed spheres, pressure drop and heat transfer in randomly packed spheres, and thermal conductivity of A 3-graphite are reported. (GF)

13955 OPTIMIZATION OF SODIUM-COOLED FAST BREEDER REACTORS USING METHODS OF NONLINEAR PROGRAMMING. Heusener, G. Karlsruhe, Ger.; Karlsruhe Univ. (1970). 109p. (In German).

Thesis.

Two methods of mathematical optimization, namely the evolution strategy and the method of permissible and feasible directions are described, as well as the application of these methods to nuclear design calculations. Approximations are used in order to save calculation time. The numeric results are given of an optimization of an oxide-fueled core and a carbide-fueled core for both an open and a closed fuel pin. The method demonstrated and explained with these examples is also applicable to fast reactors with coolants other than sodium. (GF)

Control Elements, Systems, and Instrumentation

Refer also to abstracts 12007, 12212, and 14328.

13956 (ANL-EBR-66) PROSPECTUS FOR OPERATING EBR-II WITH HIGH-WORTH CONTROL RODS. Cushman, R. A.; Sehgal, B. R.; Lowery, V. W. (Argonne National Lab., Ill.). Sep 1972. Contract W-31-109-eng-38. 96p. Dep. NTIS.

An analysis of operation of EBR-II with a system of high-worth control rods (HWCR's) was completed. Use of a HWCR system will result in a reduction in the required number of control rods

(from 10 to 8 or less) while providing a greater amount of controllable reactivity insertion. Operation of the control-rod system as part of the plant protective system is not affected, and the result of the uncontrolled insertion of an HWCR is not, in principle, different from that of a standard control rod. No significant safety problem is introduced by the use of a system of HWCR's. Operation with HWCR's is recommended. 20 references. (auth)

13957 (FEI-306) EXPERIMENTAL-CALCULATION STUDIES OF THE PHYSICS OF THE CONTROLS OF THE BN-350 REACTOR CARRIED OUT ON THE ASSEMBLY BFS-22. Orlov, V. V.; Troyanov, M. F.; Mamontov, V. F.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Fiziko-Energeticheskii Institut). 1972. 35p. (In Russian). Dep. NTIS (U. S. Sales Only).

The physics of the BN-350 reactor controls was investigated on the BFS-22 assembly. The results of "weighing" samples of different materials and of mock-ups of the controls, such as absorber rods containing a moderator, are presented. A comparative analysis of experimental and calculated data obtained with various computational methods and systems of multigroup constants was made. The depression of the neutron field was measured, and experimental and calculation studies of the sodium void effect on the reactivity in the vicinity of the absorber rods were made. (tr-auth)

13958 COMPARISON BETWEEN A PERMANENTLY WIRED AND A FREELY PROGRAMMED REACTOR PROTECTION PROGRAM. Schruefer, Elmar (AEG-Telefunken, Frankfurt am Main). At. Strom; 18: No. 9-10, 131-8(1972). (In German).

In the course of the automation of power stations process computers are being used for new purposes. The use of process computers for protection systems is new. A reactor protection system using process computers has been developed. It has been under discussion by the experts and the approval authorities since spring 1971. A short description is given of the computer system. The differences from a permanently wired system are shown. A short description is also given of the comprehensive tests which were made during the first trials of the system. (auth)

13959 INSTRUMENTATION AND CONTROL IN NUCLEAR POWER STATIONS. PART I. Gilbert, C. P.; Humphreys, J. J. (Australian Atomic Energy Commission, Lucas Heights). Contr. Syst.; 4: No. 1, 11-17(Mar 1972).

More stringent requirements are placed on the instrumentation system of a nuclear power station than on that for a more conventional plant, primarily because of the essential complexity of the reactor itself, its peculiar dynamic behavior and the damaging effects of neutron bombardment. Reactor properties, in particular those affecting instrumentation and control, are briefly described. The instrumentation system and the control system of a reactor are described. (auth)

13960 AUTOMATIC INFORMATION PROCESSING AT ATOMIC POWER STATIONS. Ermakov, V. S.; Kakhanovich, V. S.; Kal'ko, R. A.; Zalivako, E. K. At. Energ. (USSR); 33: No. 4, 847-9(Oct 1972). (In Russian).

The rapid processing of information from the operation of a nuclear power plant is discussed with a view to obtaining general parameters such as power levels, unit efficiency, and various technico-economic indices. Block diagrams are depicted for two heat-measuring devices and an efficiency-indicating device which contain flow meters, heat sensors, controllers, etc. and provide a high degree of automation. Their advantages are outlined. (K.S.W.)

13961 INSTRUMENTATION AND CONTROL OF NUCLEAR POWER PLANTS. Schallopp, B. (Kernreaktor-Instrumentierung, Berlin). Kerntechnik; 14: No. 10, 472-7(Oct 1972). (In German and English).

In recent years instrumentation in the conventional sense, i.e., the analog measuring and control techniques with individual instruments, has become increasingly integrated with automatic control and digital data processing. To avoid confusion about the diversity of instrumentation and control combinations used in nuclear power plants being built today, nuclear power plant instrumentation is discussed in terms of three basic function-related categories which are: safety or radiation protection; maintenance of the operating state or operations control; and recording. Criteria for instrumentation design for each of these functions, and the integration of such instrumentation with automatic control and data processing systems are described. (LCL)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

Refer also to abstract 11874.

13962 (BC-TOP-9) DESIGN OF STRUCTURES FOR MISSILE IMPACT. Fakhari, M.; Linderman, B.; Rotz, J.; Suarez, M. (Bechtel Corp., San Francisco, Calif.). Oct 1972. 61p.

Methods and procedures for providing missile protection for nuclear power facilities are described. Protection is provided by the structures housing the facilities, interior walls and floors, and by missile barriers. The primary objective is to ensure that the protection provided is sufficient to preclude violation of containment integrity, or damage to Category 1 equipment. Violation of containment integrity could result in release of materials that could constitute a hazard of public health and safety. Damage to Category 1 equipment could result in (or amplify) the effects of a loss of coolant accident or impede the performance of engineered safeguard systems necessary for the safe shutdown of the reactor. Therefore, the damage potential of missiles of both external and internal origin must be evaluated. The primary sources of external missiles are debris transported by tornado winds and those resulting from activities in proximity to the plant site (such as aircraft from nearby airports or hazards from nearby industrial or military activities). Internal missiles may result from energy release or forces associated with failure of power plant equipment. Typical internal missiles include parts of pressurized components such as fittings, valve parts, various nuts and bolts, and missiles resulting from pipe rupture. The definition of the missiles (and their properties) associated with the nuclear steam supply system is furnished by the nuclear steam system supplier. The site-dependent missiles are defined in an appendix. The design of structures subject to missile impact (target structures) must be such that they will not be perforated by the postulated missiles and will remain in a predictably stable condition during and after missile impact. 31 references. (auth)

13963 (HEDL-SA-409) DIFFUSION THEORY ANALYSES FOR FAST REACTOR SHIELD DESIGN. Boulette, E. T.; Marr, D. R. (Hanford Engineering Development Lab., Richland, Wash.). 1972. Contract AT(45-1)-2170. 20p. (CONF-720901-13). Dep. NTIS.

From Meeting on new developments in reactor physics and shielding calculations; Kiamesha Lake, NY (12 Sep 1972).

It is shown that diffusion theory analyses are valid for establishing liquid metal fast reactor shield designs. A carefully selected energy structure represented by fewer than 50 groups adequately treats the transport of neutron flux in a sodium and stainless steel environment. Analyses of FTR shield experiments with diffusion theory codes, using the 42-group FTR-300S cross section library, depicted good agreement with the measurements. It is believed that any accuracy loss because of the poorer neutronic model represented by diffusion theory is more than compensated for by the ability to calculate more accurate geometrical models of the reactor system. 20 references. (auth)

13964 DESIGN OF THERMAL BARRIER SYSTEMS FOR HTR. Birch, W. pp 63-83 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

Limitations on temperature and permissible gradients through the walls of concrete pressure vessels of gas-cooled reactors necessitate protective thermal barriers located on the inner vessel wall to separate the reactor coolant from the concrete. A variety of insulants has been used, or proposed, for these thermal barriers, including pumice concrete, metallic foils, metallic mesh, and mineral wool. A common structural form has emerged for the thermal barriers, featuring a sandwiched nonstructural insulant layer supported and contained by a metallic hot face cladding; this basic design is capable of being adapted to suit particular gas reactors. A review is given of the hot-face structures for containing and supporting ceramic fiber insulants, with particular regard to HTR requirements. On previous concrete pressure vessel reactors, these structures have included sliding elements to cater for thermal expansion effects, but an alternative HTR design is proposed that absorbs differential growth by flexure. Details are given of the evolution of this design, together with an experimental program. A similar hot-face structure appears to be feasible for AGR insulation duties, with the flexible elements formed with high-Ni alloys. A further proposal is an SGHWR application, where a high-integrity membrane is required to form part of the pond

bottom diaphragm structure defining the lower boundary of the reactor refueling pond, situated above the reactor core. (UK)

13965 IMPROVEMENTS IN NUCLEAR REACTORS. Webb, J.; Martin, T. C. G. (to United Kingdom Atomic Energy Authority). British Patent 1,291,721. 4 Oct 1972. Filed 29 May 1969.

Reference is made to shield plugs for closing reactor vessels. Disadvantages of conventional designs are stated, particularly as regards the provision of suitable radiation shielding material. The plug described employs a shielding composition in which these disadvantages are largely obviated. This material comprises a mixture of 60 vol % of iron shot with a binder comprising 30% of iron dust and 10% epoxy resin (preferably Araldite). It is considered essential that when the material is in position each sphere of iron shot touches all adjacent spheres and that the binder mixture occupies the interstices between the spheres. (UK)

Cooling Systems

Refer also to abstracts 11922–11924, 12240, 12386, and 12387.

13966 (AEC-tr-7363) BLOWDOWN PROGRAM FOR BOILING WATER REACTORS WITH WATER JET PUMPS. Steinhoff, F. (Technische Universitaet, Munich (West Germany)). Translated from report MRR-89. 70p. Dep. NTIS.

The design characteristics of a boiling water reactor utilizing jet pumps are analyzed. Heat transfer and fluid flow parameters for the jet pump system under blowdown conditions are calculated. 24 references. (D.C.C.)

13967 (BARC-615) WATER CHEMISTRY STUDIES. VIII. DEOXYGENATION OF REACTOR COOLANT WATER: A STATUS REPORT. Narasimhan, S. V.; Krishna Rao, K. S.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 43p. Dep. NTIS (U. S. Sales Only).

The chemical methods of scavenging oxygen from reactor boiler feed water can be divided into three groups: (i) use of chemicals dissolved in water acting as scavengers, (ii) use of ion exchange resins which have deoxidizing groups, (iii) use of ion exchange resins which firmly encage insoluble precipitates in granular form, like $Fe(OH)_2$ and $Mn(OH)_2$. Here the sites responsible for oxygen removal are entirely different from the sites in an ordinary ion exchanger. Sodium sulphite and hydrazine belong to group (i), Duolite S-10 (in Cu form) and sodium sulphite regenerated Amberlite IRA-400 fall in the second category and Ze okarb 225 resin (in acid, base, or mixed bed form) containing $Fe(OH)_2$ or $Mn(OH)_2$, is a representative of the third category. Each deoxygenating agent is treated individually followed by a critical assessment of its effectiveness. 29 references. (auth)

13968 (BARC-616) WATER CHEMISTRY STUDIES. IX. INVESTIGATIONS ON DEPOSITION AND CHEMICAL CLEANING OF MANGANESE, IRON, COBALT, AND COPPER ON METALLIC SURFACES ENCOUNTERED IN PRIMARY HEAT TRANSPORT AND MODERATOR SYSTEMS OF WATER COOLED NUCLEAR POWER REACTORS. Mathur, P. K.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 16p. Dep. NTIS (U. S. Sales Only).

Studies were carried out on deposition of manganese, iron, cobalt and copper on different metallic surfaces (stainless steel, Zircaloy-2 monel, cupro nickel and carbon steel) encountered in primary heat transport and moderator systems of water cooled nuclear power reactors. Deposition was investigated by using ^{54}Mn, ^{59}Fe, ^{58}Co and ^{64}Cu activities as tracers. Subsequent cleaning of the above surfaces was carried out using a mixture of 4.5%, H_2O_2 and 0.5% EDTA at pH of 6.8. It was found that by this method more than 95% of the deposited activities could be removed in a short period of time. However, for iron deposits, the presence of 1% oxalic acid was also essential to get a high degree of chemical cleaning. (auth)

13969 (CEA-CONF-1896) CONTROL OF TIGHTNESS OF COMPONENTS OF THE PHENIX BULK REACTOR. Blanc, B.; Roulliay, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 11p. (In French). (CONF-720553-1). Dep. NTIS (U. S. Sales Only).

From Meeting on the detection of leaks and tightness tests; Paris, France (16 May 1972).

Controls of the helium tightness were made of the welds of the principal vessel, of the double envelope vessel, and of the roof of the Phenix reactor. After a review of the structure of the Phenix, the method used for these controls and the nature of the controls made are described. Some of the values obtained are reported. (tr-auth)

13970 (CONF-721006-2) EXPERIMENTAL INVESTIGATIONS CONCERNING THE SAFETY OF SNR STRAIGHT-PIPE STEAM GENERATORS IN SODIUM–WATER REACTIONS. Dumm, K.; van Waveren, N. J. Translation of a paper from International Conference on Engineering of Fast Reactors for Safe and Reliable Operation, Karlsruhe, 9–13 October 1972. 30p. Dep. NTIS.

Experiments on sodium–water reactions were conducted in models of the SNR Reactor steam generators, and the results were used to refine analytical models of the steam generators. Calculations using the revised analytical models indicate it is possible to design a straight-pipe steam generator to withstand a large sodium–water reaction. (H.D.R.)

13971 (FRNC-CONF-41) HYDROTECHNICAL PROBLEMS ASSOCIATED WITH THE STEAM GENERATORS OF PHENIX. Andro, M.; Salon, M. (Societe Stein Industrie, Paris (France)). 1972. 6p. (In French). (CONF-720648-10). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

Problems which arose during the construction of the Phenix steam generators are discussed: distribution of the Na flow in the parallel interconnected modules and the buffer tanks of the steam generator. The application of hydraulic studies to overcome these problems is discussed. It was also possible to determine the stability and flow equality conditions for the water and steam between the tubes of a module and between the modules of the steam generator. (France)

13972 (NAA-SR-Memo-2662) NATURAL CONVECTIVE FLOW IN THE PRIMARY SODIUM SYSTEM AFTER A REACTOR SCRAM. Gershun, T. L. (Atomics International, Canoga Park, Calif.). 15 Apr 1958. 10p. Dep. NTIS.

The steady-state sodium flow rate in the Hallam reactor primary sodium system due to natural convective forces when the sodium temperatures are at the full load design values of 945°F in the hot leg and 607°F in the cold leg was determined. The possibility of one, two and three loops open for flow (0, 1 and 2 loops blocked off) was investigated. Assumptions included 14-inch and 16-inch pipes on the pump suction side and a 14-inch discharge pipe. (auth)

13973 (ORNL-TM-3777) HEAT TRANSFER SALT FOR HIGH TEMPERATURE STEAM GENERATION. Bohlmann, E. G. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 44p. Dep. NTIS.

A literature review and canvass of vendors reveal no experience and sparse, short term data bearing on the possible use of heat transfer salts (HTS –40% $NaNO_2$, 7% $NaNO_3$, 53% KNO_3) at temperatures >1000°F. Stability data found indicate that in a steam generator loop running with a maximum temperature of 1100°F about 0.5% of the $NaNO_2$ would decompose per day according to the overall reaction $5NaNO_2 \rightarrow 3NaNO_3 + Na_2O + N_2$. In the size loop envisioned for a Molten Salt Breeder Reactor (MSBR) the nitrogen produced would amount to 3400 ft^3/d. Austenitic stainless steels are recommended materials of construction above 850°F and short term test data suggest that Incoloy, Inconel, and Hastelloy-N would be resistant also. A tertiary HTS steam generator loop would provide an effective barrier to transfer of tritium formed in a MSBR to the steam generator. The tertiary loop is required to eliminate the possibility of a violent moderator graphite–HTS reaction. However, projected use in a MSBR at temperatures to ~1100°F would require a substantial development program directed at stability and/or composition re-adjustment and verification of materials compatibility. Thus, the presence of appreciable Na_2O and/or NaOH, depending on steam leakage, at such temperatures might appreciably alter the corrosion picture. An industrial installation for drying NaOH was operated one and one-half years with a maximum temperature of 980°F without difficulties due to corrosion or stability. The salt loop was constructed of ASTM 106 Grade A steel. (auth)

13974 CIRCULATOR DESIGN FOR H.T.R. Penry, D. G. pp 235-51 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

The effects of the use of He as coolant on circulator design are discussed. The properties of He at High Temperature Reactor pressures and temperatures are first considered in relation to those for CO_2 as used in other gas-cooled reactors. Typical design parameters for the HTR using He as coolant and the advanced gas-cooled reactor (AGR) using CO_2 are then enumerated, followed by circulator considerations with regard to positions of circulator in relation to reactor, circulator type and control, materials, lubrication, electric motor drive, and circulator noise. The properties of He make it possible for axial as well as centrifugal designs for

HTR circulators to be given consideration, and in this connection the axial design offers several advantages over the centrifugal design, but some serious shortcomings lead to its rejection. A centrifugal-type circulator, running at a nominal speed of 3,000 rpm and of backward-swept design of high angle to achieve a steepness of characteristics approaching that of the axial design is more feasible. Initial design and development work has led to the choice of an encapsulated centrifugal machine with all control carried out by means external to the reactor. A vertical shaft arrangement with pressure oil-fed bearings and special seals is considered practical. Future development work is indicated. (UK)

13975 MAINTENANCE OF CONTROLLED ATMOSPHERES IN H.T.R. EXPERIMENTAL LOOPS. Crawley, R. H. A. pp 129-40 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

When testing materials in He atmospheres it is necessary to simulate two reactor conditions, the first being the "dry" condition, with He containing controlled amounts of H_2 and CH_4, and the second being the "boiler leak" condition, where controlled amounts of H_2O, CO, H_2, and CH_4 are added. Because of its high cost, the He wherever possible is recirculated through the test rigs. This can lead to difficulties because of changes in impurity levels within the rigs; consequently experimental loops with He recirculation have to be designed to maintain controlled impurity levels, by dosing and/or removing impurities, and since most tests are of a long-term nature, some degree of automation is desirable if not essential. Details are given of the UK program on HTR materials testing, with particular attention to the maintenance of controlled atmospheres. The two experimental loops involved are described in detail. Analyses are fed to a computer for calculation of mean values and standard variations. (UK)

13976 PROCESS FOR PURIFYING WATER UTILIZED IN A BOILING WATER REACTOR. Shiells, D. A. U. S. Patent 3,700,550. 24 Oct 1972. Filed 21 Nov 1969.

The purity of reactor coolant is controlled by removing a stream of water from the reactor system at the pressure existing in the reactor. The removed stream is then passed to at least one low pressure area wherein the pressure is reduced to release flash steam which is employed to heat feedwater fed to the system. The water remaining after flashing is filtered to remove solids and is demineralized and is then returned as pure feedwater to the system. (Official Gazette)

13977 EFFECT OF GAS INITIAL TEMPERATURE ON THE PARAMETERS AND THERMAL EFFICIENCY OF ATOMIC STEAM–GAS PLANT. Ratnikov, E. F. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Energ.; No. 12, 63-8(1971). (In Russian).

The effect of the initial coolant gas temperature on the basic operating parameters of a nuclear steam plant was investigated. These parameters include: the pressure rise, temperature of feed water, specific consumption of the gas and other items, and the thermal efficiency of the installation. The initial gas temperature is related in a complex manner to such basic parameters. An increase of the initial gas temperature indicates a positive influence on such plant characteristics as efficiency, gas consumption, and power, and a negative influence on the capacity of the rotating aggregates. The internal efficiency of a power plant with a gas-cooled reactor is from 42 to 54%, the extent of pressure increase is from 1.5 to 3.0, feed water temperature from 250 to 260°C, and the specific gas consumption from 3.8 to 1.4 kg/kW-hr for gas temperature limits of 800 to 1,300°C, and steam pressures 88 to 235 bars. (tr-auth)

13978 EXPERIMENTAL FACILITIES FOR SAFETY ANALYSIS OF ATR AT OARAI ENGINEERING CENTER. Tokumitsu, Masashi (Power Reactor and Nuclear Fuel Development Corp., Oarai, Japan); Yoshitoshi, Shoji. FAPIG (Tokyo); No. 63, 144-50(Nov 1971). (In Japanese).

Equipment items and associated experimental facilities for safety analysis on coolant systems of boiling light water-cooled, heavy water-moderated ATR are described. The facilities were designed to reproduce accidental loss of coolant on a realistic scale. The safety experiments and associated facilities include: rupture experiment of pressure tubes in which 21 pressure tubes simulate a reactor core, and a central tube is designed to be broken by the arc method; rupture experiment of downcomer tubes in which a stainless steel rupture disk simulates rupture of a 10″ piping tube; rupture experiment of entrance piping to the pressure tubes using piston-type rapid release valves attached on two by-pass pipes to simulate rupture; and rupture experiment on main steam pipes. Performance, durability and leak tests are performed for isolation valves. (Japan)

13979 PRESSURE VESSEL COMPOSED OF PRESTRESSED CONCRETE FOR THE THTR. Haux, E. H. VDI (Ver. Deut. Ing.) Nachr.; 26: No. 28, 7(1972). (In German).

The fundamental features of the pressure vessel construction are explained and measurements on a 1 : 5 scale model of the vessel are described. The model was subjected to a cyclic load of 2.1 times the normal working pressure of 41 atm. (GF)

Fuel Systems and Components

Refer also to abstracts 12577–12580.

13980 (ANCR-1081) EVALUATION (USING A HYBRID COMPUTER) OF A SHEATH TYPE ELECTRICAL HEATER ROD FOR SIMULATING THE RESPONSE OF A NUCLEAR FUEL ROD. Larson, J. R.; Venhuizen, J. R. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nov 1972. Contract AT(10-1)-1375. 59p. Dep. NTIS.

A sheath type electrical heater rod was evaluated to determine how well the surface temperature and heat flux responses of the heater rod would simulate those of a nuclear reactor fuel rod exposed to the conditions expected to occur during a postulated loss-of-coolant accident for a pressurized water reactor. The study was conducted by modeling a single axial level of the sheath type heater and nuclear rod with a hybrid computer and imposing boundary conditions at the cladding surface. A coolant model was also included to predict boundary conditions based on the surface heat flux and local coolant conditions. A filament type rod previously used in experiments was also modeled with boundary conditions imposed at the cladding surface. Results are analyzed. 15 references. (auth)

13981 (ANL-7954) PERFORMANCE OF VIBRATORILY COMPACTED MIXED-OXIDE FUEL ELEMENTS IN EBR-II TO 2.7 AT. PERCENT BURNUP. Brown, F. L.; Neimark, L. A.; Ayer, J. E. (Argonne National Lab., Ill.). Jun 1970. Contract W-31-109-eng-38. 36p. Dep. NTIS.

Two vibrationally compacted UO_2–20 wt % PuO_2 fuel elements were successfully irradiated in EBR-II to a peak burnup of 2.7 at. % at a peak linear power rating of 17.2 kW/ft. The minor cladding diametrical increase of 0.23% can be attributed to swelling of the annealed Type 304 stainless steel cladding at a fluence of 1.8×10^{22} nvt. Homogenization of the plutonium and uranium in the Dynapak particles occurred only in the restructured fuel regions and not in the colder peripheral fuel. Structure matching suggests that the fuel-cladding interface conductance increased from an initial value of 765 to 1460 Btu/hr-ft^2-°F at the midplane because of the thermal expansion of the fuel. The variation in conductance along the length of the elements could account for the axial uniformity of the central voids and grain-growth regions. Fission-product attack of the cladding occurred to a maximum depth of 3 mils at 560°C. (17 references) (auth)

13982 (BARC-580) FAST FISSION RATIO MEASUREMENTS IN MULTI-ROD CLUSTERS. Rose, A.; Jain, H. M.; Menezes, P. F. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 52p. Dep. NTIS (U. S. Sales Only).

A series of Indo-Australian collaborative experiments to measure $^{238}U/^{235}U$ fission rate ratios in UO_2 rod cluster fuel elements is described. The measurements utilized the well known gross fission product gamma ray counting technique, with calibration by double fission chamber and ^{140}La fission product γ-ray counting techniques. Results are given for fast fission ratios measured over a range of simulated light water coolant densities from zero (air) to one (H_2O), the mid ranges being covered by use of high density expanded polystyrene, in clusters of 7, 19, 37 and 61, 14.24 mm diameter UO_2 rods. (12 references) (auth)

13983 (CEA-CONF-2095) STUDY OF THE FATIGUE OF NUCLEAR FUEL CENTERING DEVICES. Millet, P.; Weisz, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1972. 23p. (In French). (CONF-720664-1). Dep. NTIS (U. S. Sales Only).

From 15th colloquium on metallurgy. The fatigue, relations between metallurgical and mechanical aspects; Saclay, France (21 Jun 1972).

Cartridges (U tubes clad with Mg–Zr 0.5 alloy) with graphite envelopes are used as fuel elements in natural U-graphite-gas type reactors. The positioning of a cartridge inside its graphite envelope is ensured by 4 centering devices incorporated in the cladding. The rupture of some of these centering devices occurs after the cartridges have been irradiated in power reactors.

These ruptures are due to fatigue caused by alternate bending and straightening. A fatigue machine was used to carry out a series of tests on a Mg–Zr 0.5 alloy between 350 and 450°C. Tests were carried out to determine the standard deviation and the lifetimes of the centering devices of cartridges having various different geometries. In this way, the scale of the standard deviations of the fatigue curve was modified. The results obtained were in good agreement with the lifetimes observed in reactors or during long duration tests in reactor loops at temperatures in the 450°C region. The random nature of the stresses occurring was considered in developing a fissuration model based on the standard deviations of the stress distributions which was then applied to the problem. (France)

13984 (EURFNR–1022) DESIGN, IRRADIATION, AND NONDESTRUCTIVE POST-IRRADIATION EXAMINATION OF UO_2/PuO_2 FUEL PIN BUNDLE DFR-350. Gelthoff, D.; Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). May 1972. 192p. (KFK–1377). Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Within the fuel pin development for fast breeder reactors the irradiation experiment DFR-350 comprises the irradiation of a 77-pin-bundle containing UO_2-PuO_2 fuel and stainless steel cladding. The experiment was performed in the fast flux of the Dounreay Fast Reactor with NaK-cooling. The design of the fuel pins with respect of composition and geometry as well as of operational conditions was highly representative for a prototype fast reactor like the SNR-300. The fuel smear density was 80% of the theoretical value, the PuO_2-content being 20 wt %. The stainless steel cladding had a wall thickness of 0.38 mm, the pin outside diameter was exactly 6.0 mm. The pin included a fuel length of 29 cm and an axial blanket region of UO_2 in conjunction with the gas plenum. The operational conditions during irradiation are characterized by a maximum linear rod power of 450 watts/cm and a maximum cladding temperature of 630°C. The target burnup was 50,000 megawatt days per metric ton of heavy metal atoms. The design and specifications of the pins including detailed design calculations and safety considerations are presented. Irradiation in the DFR, the post irradiation examination of the whole bundle and, the nondestructive examination of the 23 German pins are described. 7 references. (auth)

13985 (EURFNR–1024) THEORETICAL STUDIES CONCERNING THE MEASUREMENT OF WALL TEMPERATURES ON SIMULATED FUEL RODS FOR THERMODYNAMICS EXPERIMENTS IN SODIUM. Moeller, R.; Tschoeke, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Apr 1972. 43p. (KFK–1555). Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The installation of thermocouples into the cladding tube of heating rods, which are heated in an indirect and stationary way, results in a disturbance of the temperature field and heat flow. Temperature fields within the zone of disturbance were calculated for various combinations of materials and corrections to the measured values were determined for the signal indicated by the thermocouple. These corrections yield the surface temperature in the undisturbed zone. Moreover, the variations of corrections to measured values were determined which are caused by uncertainties of the installation—geometry as well as of the thermal conductivity of solders. It was found that thermocouples with BN-insulation together with nickel solder in a steel sheath will cause only a small disturbance of the heat flow and, hence, provide good conditions for the determination of local surface temperatures. In this case, an accuracy of the calculated correction to the measured value of about ±25% is obtained. 8 references. (auth)

13986 (GERHTR–3) PROCESS FOR THE IDENTIFICATION OF SPHERICAL FUEL ELEMENTS OF THE HIGH-TEMPERATURE REACTOR BY MEANS OF EMISSION SPECTRUM ANALYSIS AT 40 ATM HELIUM. Lingen, P. R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translation of report JUL–671-RW. 104p. Dep. NTIS.

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

The optimal burnup conditions have been determined for emission spectrometry under 40 atm helium pressure. A few experiments of general interest, covering operating voltage characteristics, temperature determination, cathode and anode consumption, radiation intensity and line and continuum intensity as a function of pressure, have been carried out. Two applications of the technique in the high-temperature reactor (pebble-bed reactor) have been investigated: the possibility of classifying graphite spherical fuel elements with broken coated particles; and the recognition of marked spherical elements for charge identification. A draft design has been prepared of a fully automatic sparking chamber for the rapid analysis of spherical elements. (56 references) (auth)

13987 (GERHTR–15) INVESTIGATIONS ON THE DIFFUSION OF METALLIC FISSION PRODUCTS AND THE HEAVY METALS IN THE COATINGS OF FUEL PARTICLES FOR HIGH-TEMPERATURE REACTORS. Engelhard, Juergen (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Translation of report JUL–752-RG. 146p. Dep. NTIS.

Work Performed under United States–German High Temperature Reactor Research Exchange Program.

Both experimental and theoretical studies were performed about the transport of heavy metals and solid fission products into the coating of various types of fuel particles. The particles were irradiated at low temperature and, then, heated to a range between 1000 and 1600°C to simulate conditions in a high temperature reactor. Experimental studies yielded the radial distribution in the coating of fuel particles for ^{235}U, ^{232}Th, ^{233}Pa, ^{95}Zr, ^{95}Nb, ^{141}Ce, ^{103}Ru, ^{140}Ra, ^{137}Cs, and ^{131}I. A mathematical model was developed to compute coefficients for transport and evaporation. Experimental and theoretical studies showed that, up to 1300°C, no significant contamination of the cooling gas occurs in a high temperature reactor. Release of fission products could be caused by contamination of the coating with uranium as well as by defects in the coating. As far as ^{131}I was concerned, the studies showed that this fission product essentially behaved up to 1500°C like a noble gas. (43 references) (HBG)

13988 (GULF-GA-A–12081) STABILITY OF IRRADIATED COATED-PARTICLE FUELS IN A TEMPERATURE GRADIENT. Scott, C. B.; Stansfield, O. M. (Gulf General Atomic Co., San Diego, Calif.). 18 Sep 1972. Contract AT(04-3)-167. 35p. Dep. NTIS.

An important criterion of HTGR fuels containing pyrolytic-carbon-coated particles is their good integrity at high temperatures. Their lifetime at high temperatures is influenced by thermochemical interaction between the fuel kernel and the pyrolytic-carbon coatings. In reactor service, a temperature gradient exists across the fuel particle, and interaction between the kernel and coating can take the form of a unidirectional kernel migration (amoeba effect) into the hot side of the particle coating. This process is very temperature dependent and occurs only to a small extent under normal operating conditions where migration rates are relatively low. For example, heating BISO-coated ThC_2 particles in a thermal gradient of 260°C/cm will result in kernel migration rates of about 1.5×10^{-6} and 2.5×10^{-6} cm/hr at 1200° and 1500°C, respectively. A study has been made of fuel migration in coated oxide and carbide fuel particles irradiated to fast neutron fluences of 2 to 8×10^{21} n/cm^2 (E > 0.18 MeV) at temperatures up to 1450°C with subsequent heating under thermal gradients of 260°C/cm and 87°C/cm at temperatures up to 1485°C. Fast neutron irradiation and high metal burnup do not significantly affect the kernel migration rate in a thermal gradient. 14 references. (auth)

13989 (GULF-GA-A–12379) VOLATILE FISSION-PRODUCT MIGRATION AND PLATEOUT IN GCFR FUEL-ROD IRRADIATIONS. Langer, S.; Baldwin, N. L.; Campana, R. J.; Lindgren, J. R. (Gulf General Atomic Co., San Diego, Calif.); Bono, R.; Hayner, G.; Neimark, L.; Strain, R. V. (Argonne National Lab., Ill.). 8 Nov 1972. Contract AT(04-3)-167. 34p. Dep. NTIS.

The migration, plateout, and distribution of fission products in two GCFR fuel-rod irradiations have been studied by gamma spectrometry. Data were obtained during postirradiation examination of the GCFR vented fuel-rod GB-9, which was irradiated to a burnup of 54,000 MWd/Te in the thermal flux of the Oak Ridge Research Reactor, and during the interim examination of three of the seven sealed fuel rods in the GCFR F-1 (X094) assembly, which are being irradiated to burnups of 28,000 to 100,000 MWd/Te in the fast flux of the EBR-II reactor. The nonvolatile fission products were uniformly distributed throughout the fuel in both experiments. However, the volatile species migrated as vapor species from the hot regions of the fuel and plated out at the fuel-blanket interfaces, where the temperatures drop sharply. Transport of the volatile fission products into the blanket portion of the fuel rod in the pellet-cladding annulus did not occur in the GB-9 irradiation. The charcoal trap located adjacent to the insulator pellet in the GB-9 fuel rod and in the plenum of one of the F-1 fuel rods showed no measurable activity, indicating that the fuel and blanket were quite effective in retaining volatile fission products. 14 references. (auth)

13990 (NP–19599) FISSION PRODUCT DISTRIBUTION IN FAST REACTOR OXIDE FUELS. Powell, H. J. (United

Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). [1970]. 16p. Dep. NTIS (U. S. Sales Only).

The reference design of fuel pins for the Prototype Fast Reactor (PFR) has an internal diameter of only 5.08 mm, but center temperatures in excess of 2000°C and average radial temperature gradients of almost 1000°C/mm are to be expected. These steep temperature gradients provide large driving forces for migration of the various species present and the high temperature of much of the fuel should lead to high mobilities for many species. Extensive redistribution of some fission products is to be expected. Results obtained at Dounreay by post-irradiation examination of fuel pins irradiated in the Dounreay Fast Reactor (DFR) as part of the PFR fuel development program are described. 14 references. (auth)

13991 (NP-19618) STUDY CENTER OF NUCLEAR ENERGY ANNUAL REPORT 1971. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 31 Mar 1972. 39p. (In French). Dep. NTIS (U. S. Sales Only).

Fast reactor and thermal reactor development programs are reviewed. Operations and experimental facilities of the BR-2 Reactor are described. (D.C.C.)

13992 (ORNL-4825) FMODEL: A FORTRAN IV COMPUTER CODE TO PREDICT IN-REACTOR BEHAVIOR OF LMFBR FUEL PINS. Homan, F. J.; Lackey, W. J.; Cox, C. M. (Oak Ridge National Lab., Tenn.). Jan 1973. Contract W-7405-eng-26. 104p. Dep. NTIS.

A computer code to predict the in-reactor behavior of stainless-steel-clad $(U,Pu)O_2$ fuel pins is described. The code is an integration of three complex models describing the thermal, mechanical, and chemical performance of LMFBR-type fuel pins. (auth)

13993 (PNCT-831-72-1) TOKAI WORKS SEMIANNUAL PROGRESS REPORT, JANUARY-JUNE 1971. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Apr 1972. 194p. Dep. NTIS (U. S. Sales Only).

CERIUM ISOTOPES Ce-144—determination in seawater, method for
JAPANESE EXPERIMENTAL FAST REACTOR—fuel element cladding for, test fabrication of Type 316 stainless steel
MEMBRANE FILTERS—performance testing of HEPA
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fabrication of rods of
—PuO_2–UO_2, radiation testing of rods of
RADIATION DETECTORS—development of plutonium monitoring
RADIATION DETECTORS, SEMICONDUCTOR (SILICON)—development of alpha counting system with
REACTOR FUEL ELEMENTS—fabrication of plutonium oxide (PuO_2)–uranium oxide (UO_2), for water cooled power reactors
—radiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2), for water cooled power reactors
—cladding for, test fabrication of Type 316 stainless steel
REACTOR FUELS—reprocessing of, improvements in
REACTORS, BOILING—fuel elements for, fabrication and radiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2)
REACTORS, PRESSURIZED-WATER—fuel elements for, fabrication and radiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2)
STRONTIUM ISOTOPES Sr-90—determination in seawater, method for
URANIUM ISOTOPES U-235—enrichment of, centrifuge process for (DCC)

13994 (RD/B/N-2437) HELCAL 3: A PROGRAM FOR CALCULATION OF DETAILED CAN AND COOLANT TEMPERATURE DISTRIBUTIONS IN AGR CLUSTERS. Gatehouse, M. H. T.; Hutton, A. G.; Lee, M. H.; Lyall, H. G. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct 1972. 28p. Dep. NTIS (U. S. Sales Only).

The program HELCAL provides a detailed solution for the can and coolant temperature distributions in 36-pin AGR fuel element clusters. The program was written specifically to test clusters using multi-start, helical ribbing on the fuel pins and represents an advance on the current program HOTSPOT not only in this respect, but also in its ability to treat cross-channel power tilts and to give the temperature on individual pins, rather than just rings of pins. A detailed account is given of the theory embodied in the program and the method of calculation is outlined. (auth)

13995 (WASH-1236) TECHNICAL REPORT ON DENSIFICATION OF LIGHT WATER REACTOR FUELS. (Atomic Energy Commission, Washington, D. C.). 14 Nov 1972. 167p. Dep. NTIS.

An intensive review of the probable causes of gap occurrence in reactor fuel rods and of effects on reactor operation was started by the Regulatory Staff when the Ginna observations were made known. The Staff has received data from reactor fuel fabricators, including the results of post-irradiation measurements on fuel rods from a number of Westinghouse-designed plants. The results of the Staff review to date are included. Descriptions of the Ginna and Point Beach 1 fuel behavior, of the observations of flux spikes in other reactors, and of various possible mechanisms for fuel column gap formation are given. A discussion of fuel densification and associated matters is presented. One of the important results of the Staff review is the designation of the essential elements of analyses for determining the effects of fuel densification on reactor normal operating modes, anticipated transients, and possible accident sequences. These elements are described. The findings and conclusions of the Staff are also given. (30 references) (auth)

13996 NUCLEAR TUBES FOR FUEL CLADDING AND STEAM GENERATORS. Tverberg, J. C.; Draysey, J.; Depken, H.; Tivelius, B. Nucl. Eng. Int.; 17: No. 199, 1001-14(Dec 1972).

The survey comprises four articles and a data sheet. The articles cover the following topics: fabrication procedures for production of AISI Type 316 stainless steel cladding for the FFTF, produced to extremely stringent quality requirements; production of fuel cans and fuel can tubes for UKAEA reactors; quality control system arrangements for tube production adopted by Sandvik; and finally a description of the modern French factory at Montbard, France, for the manufacture of long tubes and their U-tube components for nuclear steam generators. The data sheet gives suppliers of fuel cladding and steam generator tubes with general facilities, types of tubes and indication of the reactor systems supplied. (UK)

13997 FUEL RODS OF FAST BREEDER PROTOTYPE REACTORS. Kummerer, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 11, 574-9(Nov 1972). (In German).

At present, only a few reasonably comprehensive data are available for the design of fuel rods for fast breeder prototype reactors. A comparison between various fuel rods is presented. Based on a comparison between breeder fuel rods and fuel rods for light water reactors, the initial analysis focuses on the SNR 300 fuel rod and its design criteria. Step by step, the technical data of the rods are obtained. Subsequently, all available information about fuel rods of all fast breeder prototypes is compiled. (tr-auth)

13998 FUEL PIN DESIGN FOR FAST REACTORS. McLoughlin, J. H. Nucl. Eng. Int.; 17: No. 199, 1021-4(Dec 1972).

A simple graphical treatment is used to consider all the forces set up in a fast reactor fuel pin by irradiation, such as thermal stress, fission gas pressure, and fuel swelling. The latter is determined by a velocity stress method. The forces are summed and equated to cladding strains. The results take into account cladding, fuel and performance variations and illustrate the fuel pin design conditions necessary to obtain 10% mean burnup in a large civil fast breeder reactor. (auth)

13999 GRAPHITE STRUCTURES FOR NUCLEAR REACTORS. Conference Held at London, England, March 7–9, 1972. London; Institution of Mechanical Engineers (1972). 396p. £5. (CONF-720339).

Twenty-three papers were presented. A separate abstract was prepared for each paper. (UK)

For abstracts of individual papers see: 12577–12580 and 14000–14018.

14000 MODERATOR STRUCTURE DESIGN IN THE UNITED KINGDOM: A HISTORICAL SURVEY. Hart, J. D.; Prince, N.; Simons, C. R. pp 1-15 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The history of graphite structures used in the UK power reactors from Calder Hall onwards is traced, under the following headings: The Calder moderator structure; civil Magnox reactor designs (general; effects of graphite dimensional change under irradiation; stored energy; fault considerations; core facilities; pressure containment; operating experience); Advanced Gas Cooled reactors (general); Civil AGR reactors (general; changes due to fuel; changes due to graphite; changes due to use of concrete pressure vessel); high temperature gas cooled reactors (general; Dragon reactor experiment); and civil HTR reactor designs (Oldbury B submissions). It is concluded that while moderator structures are behaving predictably, steel oxidation is posing problems and has required reactors to be run at reduced

gas outlet temperatures. There is reassurance that AGR and HTR design conditions can be met. 5 references. (UK)

14001 APPLICATION OF GRAPHITE CHEMISTRY DATA TO THE DESIGN OF GRAPHITE STACKS FOR MARK II REACTORS. Wood, E. pp 73-85 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The graphite stack of a Mark II reactor has two primary functions — the moderation of neutrons and the location of fuel and control rods — and these two functions can be affected by loss of graphite due to reaction with CO_2. The need for, and the manner of making such weight loss assessments are described. A brief discussion is first presented on the implications of graphite weight losses, and this is followed by a brief description of design solutions to the problem. The method of estimating the losses is explained with the aid of a typical example, and the relative importance of different items of chemistry data is discussed. Headings are as follows: Importance of graphite weight losses; basis of weight loss assessment; design solutions to the methane destruction problem; impressed flow solution; the hole drilling solution; the computer model; relative importance of pressure, temperature, $G(-CH_4)$, $G(-C)$; and relative diffusivity. It is concluded that weight loss is relatively insensitive to temperature and relative diffusivity, but highly sensitive to pressure, $G(-CH_4)$ and $G(-C)$. Pressure is controllable as a design variable, whereas $G(-CH_4)$ and $G(-C)$ are primarily fixed by the choice of graphite. 3 references. (UK)

14002 USE OF GRAPHITE AS A STRUCTURAL MEMBER IN AGR FUEL ELEMENTS. Prince, N.; Stacey, R. D.; Cookson, W. F.; Jones, P. M. pp 87-103 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The adoption of re-entrant gas flow in Advanced Gas Cooled reactors has caused graphite sleeves to become an essential part of the fuel element assembly. Graphite is not an ideal material for this purpose, but development work has demonstrated that a satisfactory design can be achieved that is robust enough to withstand the conditions under which the sleeves are required to operate, with considerable safety margins and having a high degree of reliability in service. Some useful experience of graphite sleeves was obtained in Magnox reactors. Among matters discussed are: graphite as a structural member; graphite specification; design of Hinkley Point B graphite sleeves; impact tests, including effect of reactor exposure; sleeve distortion during service compression tests; and operating experience. 10 references. (UK)

14003 COMPARISON OF THE DESIGN PROBLEMS EXPERIENCED WITH MAGNOX TYPE AND AGR CORE STRUCTURES. Perrett, R. J. pp 105-18 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

A description is given of some of the more important problems encountered during the design of the reactor cores for the Wylfa Nuclear Power Station, the last and largest Magnox type reactor, and Hartlepool, the most recent AGR design to be completed. The requirements and solutions reached for achieving minimum distortions on the fuelling and control rod paths, maintaining operational temperature limitations, and maintaining compatability between the structural loads and the component strengths, are among the major topics described. The techniques necessary for solving similar problems for each type of core are compared, and those aspects of core design which were introduced by the Advanced Gas Cooled type of reactor are highlighted. (auth)

14004 BASIC DESIGN PHILOSOPHY OF AN AGR CORE. Grime, C. J.; Hampson, J. D. pp 119-28 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

Experience gained in solving the problems associated with AGR core design is reviewed, and the design process indicated. Headings are as follows: functions of the core; design constraints (basic design; brick geometry; irradiation effects on graphite; graphite dimensional change in relation to core geometry; limitation of core movements; core loading and channel profiles; limitation of empty channel flow); and the design process. (UK)

14005 MECHANICAL DESIGN OF GRAPHITE STRUCTURES WITH PARTICULAR REFERENCE TO AGR CORE FOR HINKLEY POINT B AND HUNTERSTON B POWER STATIONS. Lockney, E. V. pp 129-45 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

Factors are discussed that have influenced the detailed mechanical and structural design procedures for individual components, and a brief description is given of mechanical components included in the core structure of Hinkley Point B and Hunterston B power stations. Headings are as follows: materials of construction (graphite; steels); joint design and methods of fastening (corrosion oxidated metal surfaces; welded joints; "waisted" bolts in tension; bolts used in shear; corrosion on threads); temperature assessments; site installation requirements (quality control; accessibility; cleanliness; alignment of components; installation of thermocouples); development of specific station designs; brief description of the metal core components for the graphite structure for Hinkley/Hunterston. 7 references. (UK)

14006 PRACTICAL EXPERIENCE IN THE DESIGN AND ERECTION OF THE DUNGENESS B CORE. Willson, C. F.; Harte, J. M. pp 147-66 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The main problems encountered during the design of the graphite core for Advanced Gas Cooled reactors are discussed, and a description given of the methods of solution employed for the Dungeness B reactor. The major problems are those of design and erection stemming from the behaviour of graphite under the arduous operating conditions. The design provides for a 30 yr service life. Particular emphasis is on the interconnecting radial key system, and the effects of irradiation-induced dimensional changes on the structure, imposed loadings, and oxidation effects are discussed. Sections are included on graphite machining and on erection. (UK)

14007 SITE CONSTRUCTION OF THE GRAPHITE CORE STRUCTURES FOR HINKLEY POINT B POWER STATION. Lockney, E. V.; Nixon, K. E.; Seddon, J. W. pp 167-83 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The graphite core structure for the Hinkley Point B Advanced Gas Cooled reactor is, in principle, a simple structure comprising a system of interkeyed graphite brick columns seating directly on steel support plates and connected at the periphery to a steel restraint system. Fuel element and control rod guide tubes locate in the top layer of the core structure, and the fuel element stringers are supported on steel stools attached to the support plates. Although theoretically simple, the cores must be built to a fine degree of accuracy, not usually associated with such large structures, presenting the construction engineer with difficult problems. A general description of the core structure is given, including the core itself, the core support plates, the boiler shield wall/core restraint structure, top neutron shield structure, and guide tube assemblies. Sections are included on reactor construction planning, routes and techniques for material handling, establishment of clean conditions, and in-vessel construction techniques and sequences. 2 references. (UK)

14008 DESIGN FEATURES OF THE CORE AND SUPPORT STRUCTURES FOR THE FORT St. VRAIN NUCLEAR GENERATING STATION. Nehrig, D. A.; Neylan, A. J.; Winkler, E. O. pp 185-201 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

This station, designed and built by the Gulf General Atomic Company, employs a high temperature gas cooled reactor using a highly enriched U and Th fuel cycle, He cooling and graphite moderator, housed in a prestressed concrete pressure vessel. The reactor core consists of vertical columns of hexagonal graphite fuel-moderated elements and graphite reflector blocks in cylindrical array within a steel core barrel and supported by a graphite core support structure. The core is designed to maintain a power level of 842 MW(t) in order to achieve a net output of 330 MW(e). The He coolant enters the top of the core at 47 atm. and 404°C and flows downward through the core, leaving from the bottom through the core support floor into the bottom plenum at 770°C. The core support floor structure and the large reflector blocks just inside the core barrel are permanent reactor components. The hexagonal columns are

removable by the fuel transfer machine. Details are given of the reactor core and support arrangement, the hexagonal element design, the structural design, and the seismic design. Some details are also given on the graphite properties, the effects of irradiation, graphite machining, and installation of graphite components. 9 references. (UK)

14009 DESIGN OF THE REPLACEABLE MODERATOR FOR AN H.T.R. Walker, A.; Fairbairn, J. G. pp 203-17 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The CEGB (UK Central Electricity Generating Board) is interested in a High Temperature Gas Cooled reactor which it is proposed to site at Oldbury-on-Severn; this reactor includes a requirement for on-load refuelling, and since the HTR concept is based on using integral fuel and moderator bricks refuelling at power implies removing and replacing parts of the graphite structure while subject to normal operating environmental conditions. This requirement leads to novel design features. The more important aspects of the graphite core and shield structural designs, including methods of column location, support and restraint, are reviewed under the following headings: general reactor design and parameters; fuel brick column location; design of top shield locating planes and restraints; and design of supports and lower locating plane. By arranging the fuel columns so that there is no interaction between adjacent columns over the active core length, nipping loads on fuel bricks during refuelling can be virtually eliminated, and stack restraint is only required locally at the level of the locating planes. The use of steel may also be avoided in the restraint device at the hot end of the stack. (UK)

14010 HIGH TEMPERATURE REACTOR CORE DESIGN AND BEHAVIOUR. Quick, M. V.; Richardson, D. R.; Hough, W. R. pp 219-33 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

It is stated that in the UK, for large High Temperature Reactor designs, a core in which the moderator graphite is changed with the fuel has been generally adopted in association with the "low enrichment" fuel cycle, while in the American HTRs, using the TH/^{233}U cycle, handling together of fuel and moderator is the most natural design course. These reactors use "prismatic" fuel elements in which the fuel is incorporated with the moderator in what are usually hexagonal blocks. Furthermore, in the pebble bed reactor removability of the moderator graphite is a fundamental feature of the concept. The reasoning behind the fully removable core in "low enriched" designs was to avoid limitations on fuel rating imposed by uncertainties in graphite dimensional behavior under the very high flux incurred in a permanent moderator. The shorter residence time of the graphite also reduced concern about corrosion due to impurities in the He, and eliminates the requirement for re-entrant core cooling. An essential design feature is that the fuel element is of simple construction, if the cost of replacing the entire core about every two fuel power years is not to outweigh the economic advantages of higher ratings and simpler gas circuit. A typical fuel element design is shown. Among matters discussed are: background to the fully removable core concept; core design; methods of assessing irradiation induced core distortions; stack distortions in a typical HTR core; effect of graphite distortions on core refuelling and control rod entry; effects of stack distortion on core performance; corrosion effects on graphite at high temperatures; and means of minimizing costs associated with the removable core. The work reported indicates that irradiation-induced graphite distortion effects in themselves are unlikely to create a burn-up limit in a fully removable core, at least within the limits of dose currently considered, but the effects of corrosion require further study to establish factors that cause the spread of chemical reactivity between components comprised of nominally the same type of graphite. (UK).

14011 GRAPHITE FUEL BRICK DESIGN FOR A HIGH TEMPERATURE REACTOR. Godfrey, J. B.; Ford, C. E. pp 235-54 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

Reference is made to the British Nuclear Design Corporation (BNDC) High Temperature Reactor design, the moderator of which comprises a stable arrangement of replaceable columns of graphite bricks containing the fuel pins, the latter being supported in sub-channels in the bricks. Heat generated within the moderator bricks and the fuel pins is removed by downward flow of He within the sub-channels. The bricks are hexagonal in cross-section and are stacked to form columns on an equilateral triangular lattice, the columns fitting closely only at location planes above and below the fuelled core length within the active core the intercolumn gap prevents interaction between adjacent columns as a result of irradiation induced distortion of the component bricks. Control rods can be located in holes in the fuel bricks or in special fuelless bricks. Within the reactor the fuelled moderator bricks can, depending on their location, be subject to significant thermal and irradiation dose gradients. The design of the moderator fuel brick is discussed in terms of the geometrical requirements it must satisfy as part of the reactor design, the environment in which it must operate, and its composition. The brick must be as simple as possible and cheap to manufacture, and the possibility of re-using fuel bricks for more than one fuel life is envisaged. 4 references. (UK)

14012 MARK III FUEL ELEMENT DESIGN. Robinson, J. A. pp 255-75 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

It is stated that the principle parameters of this fuel element were chosen during an iterative procedure for designing the reactor core and fuel element within the constraints of existing manufacturing methods and present achievable component endurances, in order to achieve an optimum design for which the costs are at a minimum. Some of the techniques used in assessing the endurance of the graphite components of the fuel element are discussed. Among matters considered are irradiation behavior, failure mechanisms, mathematical models for elastic behavior and for creep behavior, fatigue, and effect of multi-axial stress fields. (UK)

14013 STRESS AND STRAIN ANALYSIS OF A TUBULAR FUEL PIN. Haigh, R. E.; Simpkin, S. D. pp 277-301 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

In the tubular interacting design for a High Temperature Reactor fuel pin annular fuel compacts are contained in the space between two concentric graphite tubes, and the fuel pin is cooled by gas flowing along the outside of the outer tube and along the inside of the inner tube. The fuel compacts are made of fuel particles distributed in a graphite matrix. During irradiation the fuel compacts shrink more than the graphite tubes and any initial gap between compacts and inner tube closes, while the gap between compacts and outer tube increases. Further differential shrinkage then produces interaction between the inner tube and the compacts and the compacts are stressed in tension. These stresses tend to be relieved by irradiation creep, but can be high, and to avoid excessive cracking of fuel compacts they need to be limited to an acceptable level. Dimensional changes of the components of the fuel pin also affect the gap between fuel compacts and outer tube; this gap influences the operating temperatures by controlling the heat flow from fuel to gas coolant. Analysis of the stresses and strains in the fuel pin is therefore necessary to predict satisfactory operation, and the methods employed are described and typical results given. Among matters discussed are the mechanism of stress and strain in the fuel pin, elastic thermal stresses, stresses produced by shrinkage and temperature changes during irradiation, and application of stress/strain analysis to fuel pin design. 2 references. (UK)

14014 GRAPHITE FUEL ELEMENT SLEEVES FOR HIGH TEMPERATURE GAS COOLED REACTORS. Head, J. L.; Kinkead, A. N. pp 303-20 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

Methods used for structural analysis of fuel sleeves for High Temperature Gas Cooled reactors are described. Representative results are given from analyses of several types of fuel sleeves. (auth)

14015 STUDIES ON THE BEHAVIOUR OF GRAPHITE STRUCTURES IRRADIATED IN THE DRAGON REACTOR. Everett, M. R.; Graham, L. W.; Ridealgh, F. pp 321-45 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

A short survey is presented of the properties of graphites and

graphite/fuel compacts selected for use in High Temperature Reactor fuel elements, and experimentally determined dimensional changes and stresses are compared with predictions based on present graphite physics data. Irradiations were made in the Dragon reactor at UKAEA Winfrith. Properties examined have included dimensional changes, Young's modulus and ultimate strength, coefficient of thermal expansion, thermal conductivity, irradiation creep, and fatigue. (11 references) (UK)

14016 GEOMETRIC MEASUREMENTS ON INSTALLED GRAPHITE REACTOR CORES. Janko, A.; Wood, J. T. pp 347-65 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

A discussion is presented on the design of reactor core measuring devices. An important reactor consideration is the geometric change in the graphite that occurs during its life due to thermal expansion and irradiation, and it is important to be able to monitor core movements to ensure that the predicted movements are not exceeded, and particularly to ensure that fuel and control rods can be inserted, and that any trend in core distortions is known. Any devices used within the core must be able to operate satisfactorily at the shutdown graphite temperature. A single set of core movement measurements may not be as important as the trend shown by a series of measurements, and extrapolation of the records of past measurements could forecast the time when a control rod or fuel stringer may have a difficult passage. 7 references. (UK)

14017 GRAPHITE MONITORING OF C.E.G.B. REACTORS. Welch, F. E.; Andrews, N. L.; Phelps, B. A.; Simons, C. R. pp 367-79 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

It is considered necessary to be able to make periodic estimates of the nature, extent and consequences of graphite damage in nuclear reactors, in order to assure their continued operation with optimum efficiency over a long life. The simplest monitoring method is a repetition of design study procedure, but this method cannot disclose any unexpected effects and empirical monitoring studies are essential. Nuclear stations are equipped for moderator monitoring during the construction phase, but subsequent monitoring operations are not carried out inflexibly in accordance with a predetermined plan. The needs of each station are reviewed periodically and agreement reached on those objectives currently judged essential. Among matters discussed are the equipment of stations for monitoring, utilization of station records, physical and mechanical properties of graphites (dimensional effects, strength, stored energy and thermal conductivity), and chemical properties of graphite. Cooperation between engineering, technical and research staff of CEGB/UKAEA is outlined. 23 references. (UK)

14018 EQUIPMENT AND PROCEDURES FOR THE GRAPHITE CHEMISTRY MONITORING AND RESEARCH PROGRAMME IN THE WINDSCALE AGR. Jaquiss, M. T. pp 381-96 of Graphite Structures for Nuclear Reactors. London; Institution of Mechanical Engineers (1972).

From Conference of graphite structures for nuclear reactors; London, England (7 Mar 1972). See CONF-720339.

The principal experimental techniques that have been used in the WAGR to obtain graphite chemistry information are described. Extensive facilities for this work were developed and incorporated during construction of the reactor, some of which are still in use as originally supplied, while others have been modified or superseded; some new techniques, such as the ^{14}C monitoring procedure, have been introduced. A summary is given of graphite chemistry facilities in the reactor, and a description given of the design of the graphite monitoring stringers and the ^{14}C capsule facilities. Future developments are indicated. 3 references. (UK)

14019 ELONGATION OF FUEL RODS WITH ZIRCALOY-4-CLADDING TUBES. Manzel, R. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 17: No. 11, 563-4(Nov 1972). (In German).

During the first and second fuel element change in the nuclear power plant Obrigheim, approximately 60 fuel elements were visually examined. A detailed analysis was performed on eleven of the fuel elements with different states of burnup. In addition, length measurements were performed on about 300 rods in the underwater storage. All of the 750 fuel rods showed an increase in length regardless of manufacturer. The elongation was caused in part by neutron effects on the Zircaloy-4-cladding and by an interaction between fuel pellets and cladding. To analyze the effect further, radiation experiments are in progress. (H.B.G.)

Auxiliary Systems, Protection Systems, and Engineered Safeguards

14020 ASSESSMENT OF HTR FUELLING SYSTEMS. Blythe, R. A.; Weaving, A. H.; Worthington, N. V. pp 315-29 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

The application of the principles generic to the on-load refueling of gas-cooled reactors is discussed in particular relation to the problems specific to High Temperature Reactors. Among matters discussed are: interdependence of reactor and fueling system design; fueling machinery; requirements for on-load fueling system; off-load fueling; economic assessments; and irradiated fuel storage and transport. It is concluded that on-load refueling of a civil HTR at full power appears to be technically feasible, but considerable test and development work is required to confirm this. There is sufficient evidence available to indicate that fuel handling equipment can be made to operate in He under the conditions likely to be encountered in a downflow core, but further tribological test and development work is desirable in order to build up the requisite confidence. It would also be desirable to have facilities for the full-scale environmental testing of in-pile fueling equipment at the prototype stage in order to confirm that all the functions required within the reactor can be satisfactorily carried out. In the event of on-load fueling being selected, such a facility would need to simulate reactor temperatures and pressures, together with a range of gas crossflows, in order to establish that all parts of the reactor can be refueled—a rig of this nature would represent a significant capital investment, but if instrumental in preventing a few weeks' unscheduled outage the cost would be fully justified. (UK)

14021 DESIGN AND DEVELOPMENT OF PLANT FOR ON-LOAD REFUELLING. Emsley, G. M.; Fortey, J. pp 331-45 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

It has been shown that the cheapest off-load refueling scheme would carry a penalty of £6 to £9 per kW compared to an on-load scheme, the exact penalty depending on the design and detail engineering of the schemes considered, but even assuming the smaller penalty the economic incentive to refuel on-load is considerable. An attempt is made to define the basic engineering requirements for an on-load refueling scheme, and to describe the thinking behind the choice of a scheme suitable for the UK HTR reactor system as currently envisaged. A preferred scheme is described in detail. The use of He as coolant adds to the problems of mechanism design, and the need to conserve this expensive coolant requires development of effective gas seals and coupling, also purging operations. Further engineering problems are associated with the replaceable core concept. Problems associated with the removable core top layer, and with fuel brick and column stability, will require significant effort to produce a core design that can be safely and reliably refueled on-load. It appears feasible to develop a satisfactory scheme within the technical constraints reviewed. (UK)

14022 REFUELLING EQUIPMENT FOR HIGH TEMPERATURE REACTORS. Wheeler, D. J. pp 347-62 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

It is stated that the Mk. 3 HTR presents a novel set of problems to the designer of refueling equipment, and in attempting to solve these problems reliance has been placed on design simplicity. In order to appreciate these problems it is necessary to consider the core design, together with the pressure vessel top cap, standpipes, and the method of reactivity control. There are also problems associated with the use of He as coolant and the high temperature of reactor operation. The equipment described has been designed for on-load refueling, although it is capable of off-load working and would probably start operation off-load. Careful consideration of system requirements has led to the choice of a single fueling machine with a single upper chamber and a lower chamber containing the magazine for the contents of one irradiated column and one new column. Two kinds of fueling tool, namely a chute and a rigid mast, have been investigated, and their use will depend on the eventual fueling lattice chosen. Further development remains

to be undertaken, as well as detail solution of some problems. It may also be necessary to consider the optimum style of refueling machine if off-load refueling becomes the prime requirement. (UK)

Operation and Economics

14023 (AEEW-R-776) APEX: A FUEL MANAGEMENT CODE FOR HTR'S. Pearson, K. G. (Atomic Energy Establishment, Winfrith (England)). Aug 1972. 42p. Dep. NTIS (U. S. Sales Only).

APEX is a two-dimensional fuel management code designed to simulate in-core fuel management and load following in High Temperature Reactors operated on either the thorium or low-enriched uranium cycle. Its flexible group structure and refueling facilities should also allow the code to be used on fast reactor studies. A hexagonal mesh representation is employed with one mesh point per fuel or reflector brick stack, but a special form of the diffusion equation is used which minimizes finite difference errors. Two or more neutron groups may be employed although it is not anticipated that more than two or three would be used in studying long-term phenomena. The user has control over the fuel management strategy. Alternatively, for on-load refueling, automatic selection of refuelings is available. A restart facility allows the user to work in convenient stages and examine the acceptability of each stage before proceeding to the next. (auth)

14024 (CONF-720846-1) NUCLEAR POWER: WORLD AND AUSTRALIAN SITUATION IN PERSPECTIVE. Alder, K. F. (Australian Atomic Energy Commission). Aug 1972. 29p. Dep. NTIS (U. S. Sales Only).

From 44th congress of the Australian and New Zealand Association for the Advancement of Science symposium; Sydney, Australia (14 Aug 1972).

A perspective view of the reasons for the development of nuclear power plants in Australia and the world is presented. The current status of nuclear power plant development is discussed. (auth)

14025 (NUS-351) FUELCOST-I: A PROGRAM FOR CALCULATING NUCLEAR FUEL CYCLE COST FROM FUEL BURN-UP DATA. Kim, Y. S. (NUS Corp., Washington, D. C.). 31 Mar 1967. 51p.

The FUELCOST-I program is a digital computer code which is designed to calculate batch or equilibrium nuclear fuel cycle costs as a function of given basic cost data, fuel cycle time, and fuel burnup data. Fuel cost components and total fuel costs are given in $/kgU, in mills/kwh and/or ¢/million Btu. The program accepts, as input, several different sets of basic cost data which give different values for the inital fuel, the credit for discharged and bred fuel, the interest charges on fuel and working capital. The data on fuel fabrication, fuel exposure, plant characteristics, length of fuel cycle, spent fuel shipping and reprocessing, and material balance must be provided for each batch of fuel. The fuel materials considered in FUELCOST-I are ^{233}U, ^{235}U, ^{238}U, fissile Pu and ^{232}Th. The FUELCOST-I code is written in Control Data 3600 FORTRAN which is similar to IBM FORTRAN-IV and is designed to run under the SCOPE monitor system with a minimum number of tapes. (auth)

14026 (ORNL-TM-3852) COST PENALTIES ASSOCIATED WITH CROSS-MIXING OF HTGR PARTICLE TYPES DURING FUEL REPROCESSING. Bennett, L. L.; Thomas, W. E. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 21p. Dep. NTIS.

In the HTGR, the fertile material (thorium) and the bred fissile material (^{233}U and ^{235}U) are contained in a "fertile" particle, while the makeup fissile material (highly enriched ^{235}U) is contained in a separate "fissile" particle. The reference fuel cycle is a "selective recycle" in which these two particles are separated during the head-end operations at the chemical reprocessing plant. The bred ^{233}U is, of course, recycled. The residual makeup material (^{235}U + ^{236}U) recovered from the fissile particle is retired or sold, and fresh ^{235}U is purchased to provide fissile makeup to the HTGR. Fuel cycle calculations have assumed that complete separation of the fissile and fertile particles is possible in the head-end operation. In practice, the separation will be less than perfect, and incomplete separation may result in: some of the fertile particles becoming mixed with the fissile particles, with subsequent retirement of a fraction of the bred fissile material; or some of the fissile particles becoming mixed with the fertile particles, leading to recycle of residual makeup material containing a high fraction of ^{236}U. Either of these situations, termed "crossover" or "cross mixing," can produce a higher fuel cycle cost than the ideal complete separation of the two particles. A study was made to determine the magnitude of the nuclear performance cost penalty associated with cross mixing. Results obtained for 30-year levelized fuel costs indicate that each ten percent crossover of bred fuel (^{233}U) into the retired fuel stream would cause from .003 to .04 mill/kwhe increase in fuel cycle cost, for retired fuel values of 100 to zero % of "book value," respectively. Ten percent crossover of residual makeup fuel (^{235}U) into the recycle fuel stream causes about 0.006 mill/kwhe increase in fuel cycle cost. (auth)

14027 POSSIBILITY OF DISMANTLING A NUCLEAR POWER STATION. Suguri, Susumu (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 11, 609-13 (Nov 1972). (In Japanese).

The Japan Power Demonstration Reactor (JPDR) of the Japan Atomic Energy Research Institute has been modified to double the thermal output. During the modification, several high radiation operations were performed. A section of the biological shield concrete was removed to lay down a canal between the reactor pool and the fuel storage pool, and concrete had to be removed close to the flange of the pressure vessel. Portions of the core internals, such as the control blade and poison curtains, had to be removed and disposed of into the graveyard, and to do this an electro discharge machine was employed. By analyzing radiation levels, contamination and exposed doses during these operations, the dismantling of a nuclear power station was considered feasible. (auth)

14028 NUCLEAR POWER IS NECESSARY. Catal. Environ. Qual.; 2, No. 3, 9-14(1972).

The need for nuclear power plants to meet future electric power requirements in the U.S., hazards associated with power reactors, and the status of power reactor development are discussed. (LCL)

Safety and Siting

14029 (AEC-tr-7361(Vol.2)) INVESTIGATION OF PROCESSES IN THE PRESSURE RELIEF OF WATER COOLED REACTORS. EXPERIMENTS WITH THE 11.2 m LARGE VESSEL WITHOUT INCORPORATED STRUCTURES. 8th Report for the Federal Ministry for Education and Science. Vol. II. Final Report on Research Project RS 16. Translation of German article. 169p. Dep. NTIS.

The pressure, temperature, and coolant outflow characteristics of an 11.2 m high pressurized steel vessel following a pipe break near the vessel wall were measured. The mockup experiment was designed to simulate the pressure relief conditions following a main coolant line rupture in a water cooled reactor. The experiment is described in Volume 1, and Volume 2 presents the results of the measurements. (H.D.R.)

14030 (AEC-tr-7394) BURNOUT TESTS IN CONNECTION WITH SAFETY RESEARCH. FINAL REPORT, PARTS I AND II. Kastner, W.; Mayinger, F. Translation of a German report. 330p. Dep. NTIS.

As part of the nuclear power research program of Maschinenfabrik Augsburg-Nürnberg, Aktiengesellschaft, Werk Nürnberg, and under the aegis of the Federal Ministry of Education and Science, burnout tests were carried out under the hydrodynamic and thermodynamic conditions of pressurized water and boiling water reactors. The research in connection with safety features on four- and nine-rod clusters included: (1) Burnout tests under widely variable power distribution conditions across the rod cluster diameter. (2) Burnout behavior during reactor transients, i.e., during rapid power excursions and mass flow transients (failure of circulating pump). (3) Theoretical and practical work on unstable flow conditions in rod clusters. (4) The development of a method of manufacturing hot rods with a heat distribution which is not uniform along their length. (auth)

14031 (AI-AEC-13041) LMFBR SAFETY PROGRAMS, Quarterly Technical Progress Report, July-September 1972. (Atomics International, Canoga Park, Calif.). 15 Nov 1972. Contract AT(04-3)-824. 18p. Dep. NTIS.

LIQUID METAL FAST BREEDER REACTOR — safety programs during July to September 1972
— coolant combustion accidents in, characteristics of, (E/T)
SODIUM — combustion in liquid metal cooled fast breeder reactor accidents, characteristics of, (E/T) (D.C.C.)

14032 (BNWL-CC-2345) PROGRAM DESCRIPTION: AN INVESTIGATION OF BLOWDOWN HEAT TRANSFER AND HYDRAULICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 29 Jan 1970. Contract AT(45-1)-1830. 37p. Dep. NTIS.

A program is proposed to experimentally determine blowdown heat transfer in a BWR fuel assembly and the fluid behavior within the vessel and piping during blowdown. This will be done using a full length, electrically heated, 49-rod bundle installed in a tall vessel vertically equivalent to a full-scale BWR and sized to give

fluid and steam inventories scaled to those of a BWR. A two-loop system will be used. The blowdown from one of these loops will be carried out at scaled values to match the depressurization rates and discharge coefficients to be expected in a full-scale reactor. Transient temperature and pressure response data within the simulated fuel assembly will be determined at initial power levels typical of current BWR designs. An alternate program is proposed which will provide, in addition to the above, the measurement of liquid level, flow, and void fraction in or near the core and the measurement of steady state critical heat flux (CHF) and heat transfer coefficient beyond CHF. 23 references. (auth)

14033 (CEA-R-4368) NEW METHODS FOR THE EVALUATION OF RELIABILITY PATTERN RECOGNITION. Koen, B. V. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1972. 112p. (In French). Dep. NTIS (U. S. Sales Only).

An accurate knowledge of system reliability is essential to the evaluation of nuclear reactor safety. The evaluation of the reliability of the general, many-component system is difficult because of the problems of dimensionality and interdependency. Two calculational methods called "pattern recognition" and "heuristic programming" appear to have great potential for long range development in order to meet these problems. The correspondence between these two methods and system reliability is established. The relevant theory that will be needed in order to implement a pattern recognition program for the solution of many-switch, interdependent reliability fault trees is presented. This includes introductions to pattern recognition, list structures, tree theory, push-down lists, POLISH notation, and specific computer languages. (auth)

14034 (CENPD-43(Rev.1)(Suppl.1)) GENERIC REPORT ON COMBUSTION ENGINEERING, INC. CALCULATION MODEL FOR SMALL BREAK LOSS-OF-COOLANT ACCIDENT ANALYSIS. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Aug 1972. 29p.

A description and analyses of the small break LOCA transient based on Type II model are presented for PWR type reactors. Analytical results which show the influence of the annulus representation on the clad temperatures for the small break spectrum are included. (auth)

14035 (DUN-SA-157) FAULT TREE ANALYSIS WITH PROBABILITY EVALUATION. Crosetti, P. A. (Douglas United Nuclear, Inc., Richland, Wash.). 20 Oct 1970. 17p. (CONF-701109-6). Dep. NTIS.

From IEEE nuclear science symposium; New York, NY (4 Nov 1970).

Reliability analysis is playing an increasingly important role in quantitative assessment of system performance for assuring nuclear safety, improving plant performance and plant life, and reducing plant operating costs. In particular, fault tree analysis with probability evaluation provides an all inclusive, versatile mathematical tool for analyzing complex systems. Its application can include a complete plant as well as any of the systems and subsystems. Fault tree analysis provides an objective basis for analyzing system design, performing trade-off studies, analyzing common mode failures, demonstrating compliance with AEC requirements, and justifying system changes or additions. The logic of the approach makes it readily understandable and, therefore, it serves as an effective visibility tool for both engineering and management. (auth)

14036 (JPRS-57675) SOME CHARACTERISTICS OF A LOCAL ACCIDENT IN THE CORE OF A FAST REACTOR. Bagdasarov, Yu. E.; Kuznetsov, I. A.; Buksha, Yu. K. Translation of Nekotoryye Kharakteristiki Lokal'noy Avarii v Aktivnoy Zone Bystrogo Reaktora. 17p. NTIS.

Results of a computational investigation of processes in the core of a fast reactor during failure of heat removal in one of the assemblies are presented. (JPRS)

14037 (TRG-Report-2366) PRELIMINARY EXPERIMENTAL STUDIES OF THE INTERACTION OF WATER WITH MOLTEN LEAD AND MOLTEN SALT MIXTURES. Hillary, J. J.; Curry, P.; Taylor, L. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Dec 1972. 20p. (CONF-721006-3). Dep. NTIS (U. S. Sales Only).

From International conference on engineering of fast reactors for safe and reliable operation; Karlsruhe, Germany (9 Oct 1972).

The contacting of two liquid materials, one of which is at a temperature substantially above the boiling point of the other, can lead to explosive vaporization and the development of disruptive mechanical forces. These phenomena are of considerable interest in the study and assessment of fast reactor safety, in postulated accident situations in which the fuel/cladding may become molten and interact with liquid sodium. An apparatus, based on the tight containment shock-tube principle, was set up in which liquids can be contacted in a controlled manner and the resulting mechanical forces measured. The cold fluid (water) was supported above the hotter material (molten lead or a molten salt mixture) by a diaphragm which was failed to allow contacting to occur. The results of these experiments show that although the observed peak pressure was in no case greater than that produced by simple impact, the contacting of cold water with hot, molten, lead or a salt mixture resulted in some additional mechanical energy being transferred to the water column, manifesting itself as a multiple "bouncing" effect in this closed system. It is also clear that the efficiency of conversion of thermal to mechanical energy was quite low. This "bouncing" was completely eliminated if an inert non-condensible gas was present in the space separating the two liquids; deformation of the lead was much reduced compared with the extensive fragmentation noted in the absence of this gas. An important feature of the interaction was the restricted depth of hot liquid involved at each contacting which may limit the amount of energy which can be transferred to the water. This was observed with both lead and the salt mixture. (auth)

14038 FAULT CONDITIONS. Brown, J.; Jones, J. R. D. pp 141-61 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

In order to confirm the overall adequacy of the design of reactor plant, it is necessary to understand the behavior of the reactor system under fault conditions. The faults of major importance are those that lead to serious overheating of the reactor core, enhanced release of activity from the fuel, or damage to major plant items. These faults are first identified and discussed, and available safeguards are then indicated. The fault conditions discussed are loss of coolant flow, depressurization, transient increase in channel and core gas outlet temperatures following a reactor trip, channel gas flow reversal, natural circulation and core flow reverse, loss of feedwater flow, water ingress, and reactivity excursions. The effect of temperature transients on plant are discussed, including effect on fuel and core, pressure circuit, boilers, and reactor vessel insulation. A brief section is devoted to plant design. Transient temperature increases have to be kept to a minimum by appropriate design provisions; this requires special attention in view of the high power density of the system, its high temperature potential, and the relatively low thermal inertia of the boilers. It seems likely that present design provisions will prevent serious damage under all conceivable fault conditions. (UK)

14039 ANALYSIS OF THERMO-HYDRAULIC PROCESSES DURING SERIOUS DISTURBANCES IN WATER-COOLED REACTORS. Karwat, H. Munich; Technische Univ. (1971). 101p. (In German).

The calculation model BRUCH is described which allows the assessment of transient forces and pressure loads occurring in the wake of loss-of-coolant disturbances. Furthermore, the hydrodynamic processes within a primary cooling circuit during pressure decrease are outlined. Results of test calculations which have been carried out for a 800 MW(t) reactor and further possibilities for extending the present calculation model are discussed. (GF)

Steam and Power Conversion Systems

Refer also to abstract 12503.

14040 BOILERS FOR H.T.R. APPLICATION. Whitehouse, P. R. pp 163-76 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

Some of the main design features required in boiler plant associated with High Temperature Reactors are described. The use of high temperatures with a coolant having good thermal characteristics raises a number of problems that require accurate mathematical modeling of the system to enable detailed analysis of the boiler components to be carried out. The environmental behavior of materials, and their high-temperature strength properties, when extrapolated from relatively short-term test data to a reactor life of about 30 years, can lead to differences in interpretation and variation in values. The data used must err on the safe side, but for practical reasons will still involve some element of risk. This risk can be reduced by de-rating the design with lower gas tem-

peratures and less advanced boiler types, but this gives lower plant efficiencies and higher capital costs. Until such time as reliable data are being obtained from operating stations, the properties of materials can only be assessed from experimental work. (UK)

14041 INVESTIGATIONS ON STEAM GENERATOR MODELS OF IN-LINE TUBE ARRANGEMENT AND MULTISTART HELICES DESIGN IN PRESSURIZED AIR AND HELIUM. Groehn, H. G.; Scholz, F. pp 193-212 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

Most steam generators of modern gas-cooled power reactors are of the multi-start helices design, similar to the primary heat exchangers of the Dragon Reactor. Such arrangements can be regarded as in-line bundles of straight tubes in determining heat transfer coefficients and drag factors, but it has been found that very unequal temperature and velocity profiles can occur behind in-line tube bundles, and this might represent a disadvantage in what is in many ways a very attractive tube configuration. Some experimental work in this connection is described, performed on an existing in-line tube bank. A Babcock & Wilcox helical-type heat exchanger, of slightly different design, was also tested. Having experienced earlier that roughness increases heat transfer beyond a certain Reynolds number without increasing pressure drop in the case of in-line arrangement of the tubes, tests were also carried out on a helical-tube bank with the same geometrical dimensions and arrangements as the above-mentioned Babcock heat exchanger model, the only difference being that the coiled tubes were equipped on their outer circumference with 20 low ribs longitudinal to their axis. The tests were carried out in a pressurized gas tunnel in which the gas pressure could be varied between 1 and 40 bar at temperatures up to 400°C, so that high Reynolds numbers could be reached at fairly low Mach numbers. The test facility also allowed the use of different gases, including He. It was demonstrated that experimental data obtained with air or CO_2 can be applied to the design of He heat exchangers. Heat exchangers of the multi-start helices design do not show a marked vortex shedding frequency, as opposed to staggered bundles, and are therefore less liable to self-generated flow-induced vibrations, and no acoustic phenomena have been observed. Investigations included problems of gas mixing. In spite of the very different physical properties of air and He, the same results for heat transfer and pressure drop were obtained, and hence the results of experimental data obtained for air can be used to predict the performance of He-heated steam generators. (UK)

14042 FRETTING IN TUBE SUPPORTS OF HEAT EXCHANGERS. Fricker, H. W. pp 213-33 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

Primary heat exchangers for High-Temperature Reactors must be designed for a life of 30 years. Maintenance is normally only possible for peripheral components, and not for the heat exchanger surfaces. All inside components, including the tube supports, must be maintenance-free. The relatively high dynamic gas forces tend to set up tube vibrations and these cause relative movement and wear, or "fretting," at the tube supports. Limiting these vibrations to an acceptable level is a design problem, and it is shown how this problem can be treated. Simplified vibration analysis allows the amount of fretting wear to be determined by assuming purely frictional damping. It is shown how some important tube support requirements can be obtained in a relatively simple design. Some fretting tests are described. The tests showed that surface treatments are necessary to obtain satisfactory performance. Such treatments, however, are difficult to apply. Plasma spraying would alter the tube diameter and make coiling difficult or impossible. Nitriding could lead to surface cracking in coiling, and its application to short tube lengths would be very difficult. Applying the treatment to the support instead of the tube could be a possibility, although the beneficial effect for the tube would be limited. In the steam generators for the Fort St. Vrain reactor a "sleeve and wedge protection" system is used, in which fretting on the tube is eliminated, being transferred to the sleeve and the support plate, which are not pressure-carrying items. This system is described in detail. (UK)

14043 APPROACH TO THE DESIGN OF GAS TURBINE COMPONENTS FOR INTERGRATION WITH A HIGH TEMPERATURE REACTOR. Burylo, P. pp 253-73 of Component Design in High Temperature Reactors Using Helium as a Coolant. London; Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

Some of the design features of gas turbine components for accommodation within concrete pressure vessels, and for integration with a High Temperature Reactor, are outlined. Special attention is paid to achieve high reliability, coupled with simplicity and ease of manufacture, erection, inspection, and operation. Matters discussed include: logical development of the gas turbine integrated with a High Temperature Reactor; gas turbine components (general design philosophy, bearings and lubrication, seals, shaft flexible couplings, heat exchanger equipment, recuperators, precoolers, intercoolers, heat rejection coolers, turbines and compressors, main circuit gas valves, and instrumentation and supervisory gear); installation of compressors, turbines, heat exchangers, etc; and development work. (UK)

14044 THERMODYNAMIC ANALYSIS OF CLOSED ATOMIC GAS-TURBINE INSTALLATION CYCLES UTILIZING HELIUM. Chernobrovkin, A. P.; Shmidt, K. L. (Moscow Higher Technical School). Izv. Vyssh. Ucheb. Zaved., Energ.; No. 12, 57-62(1971). (In Russian).

A comprehensive analysis is presented of closed cycle gas-turbine installations with He as the working gas. Optimum parameters of the cycles were calculated for before-turbine gas temperature variations, and for the amount of pre-cooling and pre-heat-up. Although the question of an intermediate preheat is expeditious from the thermodynamic viewpoint, the decision on this question should be made on a technical-economics calculation, since it is associated with the erection of an auxiliary reactor. The optimum extent of regeneration was determined from various specific surfaces of regenerators. The contemporary level of development of high temperature reactors with He cooling uncovers a broad prospect of highly-economic gas turbine installations of high power for the performance of a base loading. (tr-auth)

Commercial Power Reactors

Refer also to abstract 11740.

14045 (CONF-720846-2) CURRENT STATUS AND PROSPECTS FOR COMMERCIAL NUCLEAR REACTOR SYSTEMS: THE UTILITY VIEWPOINT. Hayes, J. E.; Herbert, J. B. (State Electricity Commission of Victoria (Australia)). 1972. 33p. Dep. NTIS (U. S. Sales Only).

From 44th congress of the Australian and New Zealand Association for the Advancement of Science symposium; Sydney, Australia (14 Aug 1972).

The current status of various nuclear power plant types is outlined and future prospects for viable nuclear power generation in Australia and New Zealand are examined through discussion of current problem areas such as environmental importance, public safety, technology, performance and fuel resources. (Australia)

14046 (NP-19476) LECTURES, AUTUMN 1971-SPRING 1972. (Norsk Atomenergiforening, Oslo). Apr 1972. 126p. (In several languages). Dep. NTIS (U. S. Sales Only).

Included are 6 lectures on nuclear power plant development. A separate abstract was prepared for each lecture. (H.D.R.)

For abstracts of individual papers see: 13937, 14047, 14048, 14120, 14215, and 14216.

14047 (NP-19476, pp 1-24) EXPERIENCE IN PLANNING AND CONSTRUCTION OF NUCLEAR POWER PLANTS. Ellmer, M. (Rheinisch-Westfaelisches Elektricitaetswerk A.G., Essen). 12 Oct 1971. (In German).

The planning and building of a nuclear power plant are discussed from the point of view of the utility. The pre-project phase, the examination of operating experience, questions of reliability, and the relationship between industry and the utilities are described. The principal types of contracts are discussed with their effects on the project's economics and guarantees. Finally the setting up of specifications and the organization of the project are treated. (Norway)

14048 (NP-19476, pp 112-26) CONSTRUCTION OF NUCLEAR POWER PLANTS IN NORWAY. Lied, Finn. 21 Mar 1972. (In Norwegian).

Following a brief survey of the place of nuclear power in the Norwegian system it is stated that the State Power Authority should build the first nuclear power plant, and probably also later plants, while the local electricity authorities, who pioneered

hydroelectric construction, will administer distribution and sale. A survey of possible sites carried out during the past two years indicates that the first station will be in the Oslofjord-district, with an ultimate capacity of 3-5000 MW. By the end of the century it is possible that 5-8 such stations will be a reality. A law on concessions and licensing is before Parliament, and the establishment of a State Nuclear Inspection Authority is planned to evaluate concessions and safety clearances. Thereafter a brief discussion of environmental and organizational aspects is presented. The part to be played by Norwegian industry is discussed and finally the economic significance for nuclear power of recent finds of oil and gas in the Norwegian sector of the North Sea is briefly evaluated. (Norway)

14049 CASE FOR NUCLEAR ENERGY. Simpson, John W. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 9: No. 9, 71-3(Sep 1972).

Problems involved in the production of power in the U.S. are recounted: environmental cost of cool, scarcity of natural gas, high consumption of petroleum, etc. The advantages of nuclear power are next discussed, and some cost figures are given. The problem of reactor siting can be solved with floating reactor plants. Other ways of meeting the energy crisis are also briefly considered. (D.L.C.)

14050 APPLIED NUCLEAR POWER ENGINEERING FOR PRACTICING ENGINEERS. Pedersen, K. B.; Sasscer, D. S.; Plaza, H.; (and others). Barnes and Noble Professional Engineering Career Development Series. Boston; Cahners Books (1972). 270p. $9.95.

This book is intended for the power engineer who is not a nuclear engineer by profession. The book is arranged into five sections dealing with fundamentals (history, nuclear and reactor physics, radiation attenuation, thermodynamics), plant planning (reactor type, site selection, regulations, cost), reactor design, reactor operations, and plant operations. A bibliography of selected readings is included. (D.L.C.)

14051 FROM COAL-FIRED TO NUCLEAR POWER STATIONS: A HISTORICAL REVIEW. Boernke, F. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Mitt. Ver. Grosskesselbetr.; 50: No. 5, 362-71(Oct 1970). (In German).

The history of coal-fired power stations is given from an architectural standpoint. With progressing techniques, the architectural designs become increasingly more elegant and adapt themselves better to the landscape. A parallel development is projected for nuclear power stations. The conspicuous cupola will be replaced by rectangular designs which blend into the landscape. 27 photographic examples are presented. (H.B.G.)

14052 NUCLEAR ENERGY IN THE CONTEXT OF POWER SUPPLY IN FRANCE. Banal, M. (Electricite de France, Paris). Mitt. Ver. Grosskesselbetr.; 50: No. 6, 486-93(Dec 1970). (In German).

Described is the present energy situation in France. The demand still can be covered by fossil fuels, especially from offshore wells; therefore, large-scale development of nuclear power plants appears neither necessary nor advisable. Also outlined is the French nuclear program for the year 1970. It was decided to interrupt the program for development of graphite-moderated gas-cooled reactors and replace it with 4 or 5 nuclear power plants along the light-water line with enriched uranium. The program, however, can only be continued if the supply of enriched uranium can be secured through construction of a European enrichment center. Also discussed is the high-temperature gas-cooled reactor with uranium oxide and helium cooling as well as sodium-cooled fast breeders. Economics of the various programs are discussed. (H.B.G.)

14053 NUCLEAR ENERGY IN THE CONTEXT OF POWER SUPPLY IN GREAT BRITAIN. Booth, E. S. (Central Electricity Generating Board, London). Mitt. Ver. Grosskesselbetr.; 50: No. 6, 493-500(Dec 1970). (In German).

Presented is a historical review of the nuclear energy program in Great Britain as well as the development of policies with respect to fuel supply. Then, various reactor types are compared and problems of site selection are analyzed. Following presentation of the present status of nuclear power plants, experiences with gas-cooled reactors are reported, especially those with AGR reactors. At the end of 1970, twelve AGR reactors of the Mark II type are in various stages of planning or operation with a total power of approximately 8000 MW. After conclusion of the Mark I and the Mark II programs, the British nuclear industry centers its efforts on the development of the gas-cooled reactor Mark III which is based partially on the helium-cooled high-temperature reactors of the Dragon project. Future reactor systems are briefly outlined. (H.B.G.)

14054 PICKERING: ONE YEAR OF SATISFACTORY OPERATION. Com. Naz. Energ. Nucl., Notiz.; 18: No. 8-9, 96-106(1972). (In Italian).

A description is given of the Pickering Nuclear Power Plant and of its satisfactory operation in its first year of life. (auth)

14055 PROSPECTS FOR FAST NEUTRON REACTORS IN FRANCE. Denielou, G. (CEN de Cadarache, Saint-Paul-les-Durance, France); Yvon, J. Rev. Fr. Elec.; 45: No. 238, 10-17 (1972). (In French).

In the framework of the French nuclear program, a 1200-MW(e) nuclear power plant producing 3000 MW(t) is envisaged as a follow-up to Rapsodie Fortissimo (40-MW(t) test reactor) and Phenix (600-MW(t) prototype plant). The construction of such a plant is considered as a technological development from Phenix. This plant was planned from both the economic and safety point of view. The principal components envisaged for the plant are a single core, 4 primary pumps, 4 secondary circuits, a single common steam point, and very probably two turbogenerators. The design of the core is very similar to that of Phenix. The EDF (Electricite de France) foresees operation as a basic power plant, emphasis being given to the charge factor and the capability of the plant to continue operating in the event of a partial breakdown. Safety considerations relate to the compactness of the core and the risks of sodium–fuel reactions. (France)

14056 CONSTRUCTION OF TAKAHAMA NUCLEAR POWER PLANT. Ohno, T.; Nakamura, K. (Kansai Electric Power Co. Inc., Osaka). Hatsuden Suiryoku; No. 114, 3-46(Sep 1971). (In Japanese).

A nuclear power plant is under construction at Takahama town in Fukui prefecture. This 2 × 826 megawatts plant is to start operation in August 1974. Before starting the construction, preparatory investigations on topography, geology, water facility, earthquake, and intake and discharge of cooling water were performed and resulted in satisfaction. For cost reduction, site construction and arrangement of equipment were effective. The arrangement of equipment was decided finally at the eighth design stage. Intake of the cooling water is inland pump room-type. The construction comprises site preparation, intake and outlet channels of the cooling water, landing pier, repair of prefectural roads, etc. This plant was designed to be safe against earthquakes. Site design had to be decided before design of machinery and tools was finished. (Japan)

14057 TECHNICAL AND ECONOMIC DEVELOPMENT OF POWER GENERATION IN THE GERMAN FEDERAL REPUBLIC. Mandel, H. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Mitt. Ver. Grosskesselbetr.; 50: No. 4, 265-73(Aug 1970). (In German).

The historical development of power generation is analyzed for West Germany. Various trends can be characterized; these are discussed with respect to modular power unit and assembly of power plants, conditions of fresh steam, preheating, and condensor pressure. Also discussed are trends in turbine systems and heat exchangers. Further discussed is the optimal combination of power plants and gas turbine installations. With increasing complexity of the power installation, automatization more and more becomes a necessity. As to size, 300-MW power units are superior to 150-MW units and, thus, units of 600-MW and higher are projected for the future. Effects on the environment are mentioned. (H.B.G.)

14058 STEAM GENERATING HEAVY WATER REACTOR (S.G.H.W.R.) FOR ELECTRICAL POWER GENERATION FROM PROTOTYPE TO COMMERCIAL. Hughes, H. G. D. Cost Eng.; 11: No. 4, 1-16(Jul 1972).

The principal features of the SGHWR system are summarized. The construction of the prototype reactor is described and the following components discussed in detail: channel tube assemblies, coolant system, fuel handling system, containment, control system, and turbine generator. Reference is made to the techniques of cost and budgeting control and of cost estimating. Some of the improvements made in the development of the commercial versions of the reactor are also described with particular reference to those which have a significant effect on cost. (UK)

14059 NUCLEAR POWER. AGR AND BWR: A QUESTION OF STRUCTURE. Layton, C.; Marlow, C.; de Houghton, C. pp 131-45 of Ten Innovations. /Layton, C. London; George Allen and Unwin Ltd. (1972).

The main lines of development of power-producing reactors in the UK and US are compared, and reasons suggested for the greater success of American industry in selling reactors in world markets. It is stated that two points—price, and faults of delays and decision-making—make it necessary to look more closely at (a) the economics of competition between the British Advanced Gas-cooled Reactor and the American Boiling Water Reactor, and

(b) organization. The deployment of qualified scientists and engineers in the development of reactors in the two countries is compared. It is concluded that in nuclear power the UK effort is over the minimum "threshold" for a development effort, but is being spread over a much narrower market than the American effort, which therefore enjoys economies of scale. It is considered that there are fewer economies of scale on the production side, but the size of the two major American companies has given them the financial strength to loss-lead and thus create their massive market. Differences in organization of the nuclear power industry between America and Britain are discussed, and the reorganization of the British industry, which finally crystallized in the summer of 1969. Finally, steps towards a major European nuclear reactor enterprise are examined, and the part that the UK might play in future developments in Europe is discussed. (UK)

14060 300 MW THTR NUCLEAR POWER STATION AT UENTROP. Mueller, H. W. (Hochtemperatur-Reaktorbau GmbH, Mannheim, Ger.). Kerntechnik; 14: No. 9, 385-90 (Sep 1972). (In German and English).

The construction of the 300 MW THTR, started in May 1972, introduces in the Federal Republic of Germany the second generation of nuclear power stations. Owing to its favorable safety characteristics and low waste heat generation, the HTR is suitable for locations in high population density areas. The operating experience with the AVR has not only confirmed the advantages of the fuel element concept and the stable operating performance of the high temperature reactor, but has also provided valuable information for the design of the THTR. The essential design principles of the THTR are similar to those of the AVR, except for the concepts of the reactor pressure vessel and of the shutdown rods, which have been altered. (auth)

Physics and Core Engineering

14061 (BAW-10037(Rev.2)) REACTOR VESSEL MODEL FLOW TESTS, REVISION 2. (NONPROPRIETARY VERSION OF BAW-10012). Mullinax, B. S.; Walker, R. J.; Karrasch, B. A. (eds.) (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Div.). Nov 1972. 4p.

Hydraulic tests on a one-sixth-scale model of a two-loop pressurized water reactor with 177 fuel assemblies are described. The following areas were investigated: (1) Core inlet and outlet flow distribution; (2) Vessel pressure drop; (3) Gross mixing of the fluid entering the core and within the core; and (4) Vent valve closing forces. The core inlet flow distribution was found to be highly dependent on the flow conditions in the inlet annulus and the thermal shield regions. A distribution system consisting of several flow baffles was developed to obtain a uniform and stable core inlet flow distribution. A uniform core outlet flow distribution similar to the inlet distribution was established by placing a turnaround baffle between the core outlet and the outlet nozzles. (auth)

14062 NUCLEAR POWER PLANT FOR OKLILUOTE. Vaara, E. I.; Haga, I. Nucl. Eng. Int.; 17: No. 199, 1018-20(Dec 1972).

The Teollisuuden Voima nuclear power station to be built on the island of Olkiluoto on the west coast of Finland will be a 660 MW(e) BWR. Descriptions are given of the core and fuel assembly design, internal recirculation pumps and prestressed concrete containment. Additional new features include a compact off-gas treatment system and emergency core cooling which is provided by two systems, a high pressure auxiliary feed water system and a low pressure core spray system. (UK)

Control Elements, Systems, and Instrumentation

14063 (WCAP-7817(Suppl.4)) SEISMIC TESTING OF ELECTRICAL AND CONTROL EQUIPMENT (WCID NUCANA 7300 SERIES) (LOW SEISMIC PLANTS). Reid, J. B. (Westinghouse Electric Corp., Pittsburgh, Pa.). Nov 1972. 15p.

Seismic testing and criteria for seismic testing of electrical and control equipment over the range of 1 Hz to 35 Hz are discussed. To demonstrate the ability of the equipment to perform under such earthquake disturbances, it was subjected to vibration tests which simulated the seismic conditions for the "low seismic" class of plants. During testing, the equipment was operated and the critical functions monitored to verify proper performance. The results show that there were no electrical irregularities that would leave the plant in an unsafe condition. (auth)

14064 MAIN INVESTIGATIONS CARRIED OUT BY VTI WITH RESPECT TO AUTOMATION OF THERMAL POWER EQUIPMENT. Mironov V. D.; Boloban, P. E.; Davydov, N. I.; Sergievskaya, E. N. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 7, 15-20 (Jul 1971).

Translated from Teploenergetika; 18: No. 7, 14-18(Jul 1971).

A historical survey is given of the development of automation of power generating plants. The following are covered: boiler units, turbine plants, control systems for generating units, chemical treatment of water, and nuclear power plants. Problems in the automation of a nuclear power plant are listed. (D.L.C.)

14065 SOME PHYSICAL ASPECTS OF THE USE OF BORIC ACID IN THE RHEINSBERG NUCLEAR POWER PLANT. Frach, K.H. (VEB-Kernkraftwerke Greifswald, Rheinsberg, Ger.). Kernenergie; 15: No. 3, 81-4(Mar 1972). (In German).

Experiments using the method of dynamic reactivity measurement for determination of boric acid coefficient of reactivity or effect of boric acid have been carried out on the Rheinsberg nuclear power plant at zero power range. Dependence of boric acid coefficient of reactivity on both boric acid concentration and moderator temperature was studied for various concentrations. Efficiency of the control assemblies was determined. The problems which occurred during performance of the experiments and their evaluation are summed up. (auth)

14066 EMPLOYMENT OF DATA PROCESSING INSTALLATIONS IN THE WUERGASSEN NUCLEAR POWER PLANT. Maygatt, M.; Kahnert, H. (Preussische Elektrizitaets AG, Hanover). Energie; 24: No. 7-8, 187-90(1972). (In German).

The process computer installations using two AEG 60-10 computers and one AEG 60-50 computer are described, and the planning, the starting-up, and the results of the operation of the installations are discussed. (GF)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

14067 (BN-TOP-1(Rev.1)) TESTING CRITERIA FOR INTEGRATED LEAKAGE RATE TESTING OF PRIMARY CONTAINMENT STRUCTURES FOR NUCLEAR POWER PLANTS. Cranston, G. V. (Bechtel Corp., San Francisco, Calif.). 1 Nov 1972. 121p.

Data are presented to justify containment leakage rate tests for durations of less than 24 hours for both pressurized water reactor and boiling water reactor containments. The recommended criteria for determining when a containment integrated leak rate test is successfully completed are presented. The instrumentation used is described, and detailed explanations as to how the leak rate is determined and reported are presented. (H.D.R.)

14068 (BN-TOP-3) PERFORMANCE AND SIZING OF DRY PRESSURE CONTAINMENTS. Schwartztrauber, K. E.; Pervich, M. P. (Bechtel Corp., San Francisco, Calif.). Dec 1972. 58p.

Functional design and accident performance characteristics of dry pressure containments are established using analytical techniques and design parameter selection methods adopted by Bechtel Corporation for light-water reactor nuclear power plant containment. The analytical techniques employed to predict thermodynamic performance during postulated loss-of-coolant accidents and the models, assumptions and systems treated in the Bechtel containment analysis computer program COPATTA are given. A typical pressurized water reactor containment transient is analyzed to illustrate the methods established. The determination of design conditions and selection of design margins, based upon established AEC guidelines requiring a minimum design pressure rating margin of 10%, is reported. 16 references. (auth)

14069 (WASH-1226-7(Suppl.)) CONTROL OF COMBUSTIBLE GAS CONCENTRATIONS IN CONTAINMENT FOLLOWING A LOSS-OF-COOLANT ACCIDENT. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 27 Oct 1971. 1p. Dep. DRS, USAEC, Washington, D. C.

Backfitting considerations for combustible gas control systems to plants already licensed are presented. (H.D.R.)

Cooling Systems

Refer also to abstract 12448.

14070 (CONF-701074-3) HIGH-POWER STEAM GENERATORS FOR ATOMIC ELECTRIC POWER PLANTS WITH WATER-MODERATED WATER-COOLED REACTORS. Titov, V. F.; Grishakov, V. I.; Tarankov, G. A.; Suprunov, V. G.; Denisov, V. P.; Stekol'nikov, V. V. Translated from pp 313-25 of Proceedings of the Scientific and Technical Conference on Atomic Power, Fuel Cycles, and the Radiation Study of Materials, Ul'yanovsk, USSR, 5-10 October 1970, Vol. I. 10p. Dep. NTIS.

The designs of horizontal and vertical steam generators for units of nuclear power plants with water-moderated water-

cooled power reactors with a capacity of 1000 MW(e) and with four circulation loops were examined. Light has been shed on the principal aspects in the creation of transportable steam generators with a high unit capacity. Substantiations are given for the principal decisions adopted in the development of the main structural assemblies of the steam generators. It is shown that the requirement of increased reliability in the presence of increase of the unit capacities of the equipment of nuclear power plants, including the steam generators, caused a considerable volume of experimental work to be done in the area of the hydrodynamics of mixtures of steam and water, the separation of steam and the strength of individual structural assemblies. An analysis was made of the possibilities of creating steam generators with natural circulation of the boiler water with the generation of superheated steam. (auth)

14071 BEHAVIOUR OF CONSTRUCTIONAL MATERIALS IN MARK 3 HELIUM COOLED REACTORS. Tyzack, C. (United Kingdom Atomic Energy Authority, Risley, Eng.); Wood, D. S.; Cowen, H. C.; (and others). pp 1-39 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

It is stated that while the He bulk coolant is chemically inert the behaviour of constructional materials is dependent in a complicated manner on the concentration and in some cases the ratios of impurities present. The precise coolant composition will determine whether the overall situation is oxidizing or reducing, carburizing or decarburizing, and whether components are likely to be subjected to nitriding. Thermodynamically the oxidation potential of the system could be determined by the CO/CO_2 ratio or by the H_2/H_2O ratio, but operational data suggest that it is determined primarily by the latter. The carburizing potential may be determined by the $CH_4/(H_2)^2$ ratio or the reaction between CO and H_2 to produce moisture plus C, and it is probably the latter that predominates. Impurity input processes are not quantifiable and depend on the particular plant, with regard to boiler leak rates, the amount of H_2 that diffuses through boiler tubes, oil in-leakage, and outgassing from C bricks. Kinetic aspects are also often important. Moisture content of the He is also an important factor. A review is presented on situations where the nature of coolant impurities might be expected to modify high temperature behaviour, including oxidation and carbon transfer and effect on mechanical properties, tribological aspects, etc. Headings include: formulation of test atmospheres; compatibility aspects (mild steels, low alloy steels, austenitic steels, Ni-based alloys, special effects at crevices); mechanical property aspects (proof stress, creep rupture, fatigue, welds); and tribology aspects (fretting, static adhesion, friction, and wear). Among the conclusions reached is that many material properties depend significantly on the presence of coherent oxide films on the surface; such films also play a role in restricting C transport to or from materials. (UK)

14072 COMPONENTS OF THE THTR 300 HEAT TRANSFER SYSTEM. Cramer, H.; Hagstotz, G.; Eiermann, A. pp 177-91 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

In this pebble bed reactor system, the He coolant flows through a core consisting of 675,000 93%-enriched UO_2 coated fuel element spheres in statistical distribution and is heated from 267 to 795°C. Thorium is added as breeding material. Downflow was selected for the core to reduce temperature stresses in the loop reflector and avoid lifting the spheres. Six steam generator/blower units are provided for removal of decay heat. Provision is made for increasing the reactor to 600 MW, with 12 steam generators. Details are given of the heat transfer components and of the He blowers. (UK)

14073 HELIUM QUALITY CONTROL AND CIRCUIT PURIFICATION. Collins, A. C.; Gliddon, B. J.; Phennah, P. J. pp 105-28 of Component Design in High Temperature Reactors Using Helium as a Coolant. London: Institution of Mechanical Engineers (1972).

From Conference on component design for high temperature reactors using helium as a coolant; London, England (3 May 1972). See CONF-720549.

In the HTR, oxidation of the graphite core by traces of impurities in the He coolant can occur; the origin of these impurities is discussed, together with their effect on reactor operation. A description of the duties of the He purification plant in maintaining the required gas composition is given, together with the philosophies of current purification schemes (the AVR system, the Gulf General Atomic HTGR system, and the Dragon Project). Sections discuss basic information requirements and experimental work. Results are given for water vapour and CO_2. Matters discussed also include intra-particle diffusion coefficients, packed bed performance, kinetic control in field beds, and bed regeneration. (UK)

14074 SAFETY MANAGEMENT OF COOLANT SYSTEMS FOR LIGHT WATER REACTORS. Koyama, H.; Kurosawa, T. (Central Research Inst. of Electric Power Industry, Tokyo). Kogyo Yosui; No. 161, 13-20(Feb 1972). (In Japanese).

The importance of safety management of primary coolant systems for light water moderated reactors is emphasized. As introductory remarks, the roles of water as moderator and as coolant are briefly explained. The coolant systems for both BWRs and PWRs are also explained. Necessity and importance of managing quality of the coolant water are discussed from the viewpoint of radioactivity. It is also stressed that the only method of knowing the status of fuel rupture and corrosion of structural materials is analysis of the coolant water. Radioactive nuclides present in the coolant water are listed together with their half lives and actual amount of presence. Criteria for pH value, dielectric constant and amount of specific ions being applied for BWRs and PWRs are also listed. Finally, effect of the pH value and content of oxygen on corrosion and scale buildup are discussed based on some experimental data. (Japan)

14075 MANUFACTURE OF PRESSURE VESSELS FOR NUCLEAR REACTORS. Verzijlbergh, C. J. (Rotterdam Dockyard Co.). Zvaranie; 20: No. 4, 97-103(Apr 1971). (In Slovak).

Main aspects are described of the manufacture of pressure vessels for BWR and PWR reactors. Experience with welding and quality inspection is dealt with in detail, as gained by Rotterdam Dockyard Co., Holland. The design is required to meet current national regulations and standards. The safety requirements for the materials used are very exacting. The steel grades used for the manufacture are listed. The technology of forging rings and the welding methods are described; attention is paid to filler materials for the electrodes. Methods of improving the final structure of welds and their mechanical properties are analyzed. To ensure high quality it is necessary that adequate inspection methods be proposed and very carefully observed. (NSA of Czech.)

Fuel Systems and Components

14076 (GULF-GA-A-12325) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1972. (Gulf General Atomic Co., San Diego, Calif.). 31 Oct 1972. Contract AT(04-3)-633. 42p. Dep. NTIS.

The work reported includes nuclear analysis of the fuel cycle, fuel zoning, and power shaping. The performance of test fuel elements is studied by means of irradiation at expected operating temperatures and capsule irradiation tests of production fuel. (auth)

Auxiliary Systems, Protection Systems, and Engineered Safeguards

14077 DUMP VALVE TO PROTECT SEALED COMPARTMENTS IN NUCLEAR POWER STATIONS. Mal'tsev, B. K.; Rzheznikov, Yu.; Puzyrev, L. N.; Gryzlov, A. G. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 8, 90-3(Aug 1971).

Translated from Teploenergetika; 18: No. 8, 62-5(Aug 1971).

A dump valve is designed for operating when failure occurs simultaneously in the piping and water injection system. The valve consists of a disc, nozzle, rubber sealing ring, rods, weight, and shock absorber. Equations were derived and model experiments conducted to study its oscillations. Experimental discharge and force coefficients are presented. Dynamics were calculated for failure of a 200-mm dia pipe. (D.L.C.)

14078 RELIABILITY METHODS FOR ON-LINE MEASUREMENT TECHNIQUES. TESTING MANEUVERS WITH REACTOR SAFETY SYSTEMS. Herrmann, H. Munich: Oldenbourg (1972). 160p. (In German).

Methods for reliability testing of the emergency feed water system of a BWR after a failure with loss of coolant are described. The detected errors have also been evaluated. (GF)

Operation and Economics

14079 (BAW-10050(Rev.1)) EVALUATION OF OCONEE REACTOR COMPONENT FAILURE. (Babcock and Wilcox Co.,

Lynchburg, Va. (USA). Nuclear Power Generation Div.). Nov 1972. 5p.

An investigation was conducted to evaluate the failure of certain Oconee 1 reactor components during hot functional tests in early 1972. (auth)

14080 (DOCKET-50003–149) INDIAN POINT STATION, UNIT 1. Leaky Valve December 12, 1972. Flux Flow Computer Scram December 19, 1972. Desuperheating Water Line Failed December 29, 1972. (Consolidated Edison Co. of New York, Inc., New York). 5 Jan 1973. 7p. Dep. NTIS.

14081 (DOCKET-50029–221) YANKEE NUCLEAR POWER STATION. Diesel Generator Coolant Hose Failure. (Yankee Atomic Electric Co., Westboro, Mass.). 10 Jan 1973. 2p. Dep. NTIS.

14082 (DOCKET-50155–135) BIG ROCK POINT NUCLEAR PLANT. Failure of Valve to Close on Manual Initiation. (Consumers Power Co., Jackson, Mich.). 20 Dec 1972. 1p. Dep. NTIS.

14083 (DOCKET-50171–110) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Slow Scram Speed of Control Rod on Routine Testing. (Philadelphia Electric Co., Pa.). 22 Dec 1972. 2p. Dep. NTIS.

14084 (DOCKET-50213–171) HADDAM NECK PLANT, UNIT 1. Operation Report No. 72-11 for the Month of November 1972. (Connecticut Yankee Atomic Power Co., Haddam). 26 Dec 1972. 15p. (NYO–3144-78). Dep. NTIS.

14085 (DOCKET-50213–172) HADDAM NECK PLANT, UNIT 1. Containment Air Leakage. (Connecticut Yankee Atomic Power Co., Hartford). 28 Dec 1972. 6p. Dep. NTIS.

14086 (DOCKET-50219–226) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Change Request 13. (Jersey Central Power and Light Co., Morristown, N. J.). 15 Jan 1973. 12p. Dep. NTIS.

Revised technical specifications are presented concerning abnormal occurrences and reporting requirements for reactor operations. (DCC)

14087 (DOCKET-50237–288) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. QUAD-CITIES STATION, UNITS 1 AND 2. LA SALLE COUNTY STATION, UNITS 1 AND 2. Fuel Densification Effects. (Commonwealth Edison Co., Chicago, Ill.). 3 Jan 1973. 1p. (DOCKET-50249–179; DOCKET-50254–153; DOCKET-50265–142; DOCKET-50373–29; DOCKET-50374–28). Dep. NTIS.

14088 (DOCKET-50237–290) DRESDEN NUCLEAR POWER STATION, UNIT 2. Main Steam Isolation Valve Leakage Test; HPCI Valve Failed to Open. (Commonwealth Edison Co., Chicago, Ill.). 28 Dec 1972. 4p. Dep. NTIS.

14089 (DOCKET-50244–134) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Monthly Report of Activity Measurements, October 26–November 25, 1972; Unplanned Release of Radioactive Gases, August 31–September 1, 1972. (Rochester Gas and Electric Corp., N. Y.). 28 Dec 1972. 4p. Dep. NTIS.

14090 (DOCKET-50244–135) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Physics Measurements of Cycle III. (Rochester Gas and Electric Corp., N. Y.). 28 Dec 1972. 13p. Dep. NTIS.

14091 (DOCKET-50245–180) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Chloride Intrusion Incident, Specific Discussion Items. (Millstone Point Co., Hartford, Conn.). 26 Dec 1972. 8p. Dep. NTIS.

14092 (DOCKET-50245–181) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Proposed Change. (Millstone Point Co., Hartford, Conn.). 5 Jan 1973. 9p. Dep. NTIS.

Revised technical specifications are presented concerning surveillance requirements for auxiliary electrical system batteries. (D.C.C.)

14093 (DOCKET-50250–108) TURKEY POINT PLANT, UNITS 3 AND 4. Design Deficiency in Instrument Power System. (Florida Power and Light Co.). 11 Dec 1972. 5p. (DOCKET-50251–88). Dep. NTIS.

14094 (DOCKET-50250–109) TURKEY POINT PLANT, UNIT 3. Battery Charger Fire. (Florida Power and Light Co.). 22 Dec 1972. 2p. Dep. NTIS.

14095 (DOCKET-50254–156) QUAD-CITIES STATION, UNITS 1 AND 2. Improper Valve Line-Up Resulted in Loss of Flow to Main Chimney Sample System. (Commonwealth Edison Co., Cordova, Ill.). 22 Dec 1972. 3p. (DOCKET-50265–146). Dep. NTIS.

14096 (DOCKET-50254–157) QUAD-CITIES STATION, UNITS 1 AND 2. Setpoint Drift of an EHC Oil Pressure Switch. Loss of Flow to Main Chimney Sample System. (Commonwealth Edison Co., Cordova, Ill.). 11 Jan 1973. 4p. (DOCKET-50265–148). Dep. NTIS.

14097 (DOCKET-50261–134) H. B. ROBINSON UNIT 2. Monthly Report of Primary and Secondary Activity Measurements and Effluent Discharge Activity Levels for November 1972. (Carolina Power and Light Co., Raleigh, N. C.). 3 Jan 1973. 2p. Dep. NTIS.

14098 (DOCKET-50261–135) H. B. ROBINSON UNIT 2. Response to Noncompliance Report of November 10, 1972. (Carolina Power and Light Co., Raleigh, N. C.). 30 Nov 1972. 7p. Dep. NTIS.

Additional information is presented concerning the boron injection tank concentration and temperature. (D.C.C.)

14099 (DOCKET-50263–166) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Provisional Operating License No. DPR-22, Application for Amendment 2, Supplement 1. (Northern States Power Co., Minneapolis, Minn.). 21 Dec 1972. 5p. Dep. NTIS.

Revised information is presented concerning estimated five year operating costs and possession limits for cesium-137 and strontium-90. (D.C.C.)

14100 (DOCKET-50263–168) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. RHR Pump Motor Failure; Reporting of Torus-to-Drywell Vacuum Breaker Problems; Main Steam Isolation Valve Performance; Performance of the Reactor Coolant Leakage Detection System. (Northern States Power Co., Minneapolis, Minn.). 28 Dec 1972. 15p. Dep. NTIS.

14101 (DOCKET-50263–172) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. RHR Service Water Pump Seal Problem. Information Relating to Torus Ring Header Supports. (Northern States Power Co., Minneapolis, Minn.). 11 Jan 1973. 3p. Dep. NTIS.

14102 (DOCKET-50265–144) QUAD-CITIES STATION, UNIT 2. Drift of Reactor Protection System Scram Instruments. (Commonwealth Edison Co., Cordova, Ill.). 27 Dec 1972. 2p. Dep. NTIS.

14103 (DOCKET-50265–145) QUAD-CITIES STATION, UNIT 2. Main Steam Isolation Valve Closure Time in Excess of Technical Specification Limits. (Commonwealth Edison Co., Cordova, Ill.). 3 Jan 1973. 3p. Dep. NTIS.

14104 (DOCKET-50265–147) QUAD-CITIES STATION, UNIT 2. Cleanup Outboard Isolation Valve Failed to Close December 24, 1972. (Commonwealth Edison Co., Cordova, Ill.). 5 Jan 1973. 4p. Dep. NTIS.

14105 (DOCKET-50265–149) QUAD-CITIES STATION, UNIT 2. High Level in Unit 2 Suppression Chamber. Abnormality in the Sodium Pentaborate Solution Level. (Commonwealth Edison Co., Cordova, Ill.). 9 Jan 1973. 6p. Dep. NTIS.

14106 (DOCKET-50266–94) POINT BEACH NUCLEAR PLANT, UNIT 1. Suspected Exposure of Five to Six Rem to Employee October 5, 1972. (Wisconsin Electric Power Co., Milwaukee). 6 Oct 1972. 1p. Dep. NTIS.

14107 (DOCKET-50271–127) VERMONT YANKEE NUCLEAR POWER STATION. Operations Report No. 72-9 for Month of September 1972. (Vermont Yankee Nuclear Power Corp., Rutland). 2 Jan 1973. 32p. Dep. NTIS.

14108 (DOCKET-50271–128) VERMONT YANKEE NUCLEAR POWER STATION. Release of Short-Lived Radioactive Gas, December 12, 1972; No. 1 Fan on West Cooling Tower Tripped, December 20, 1972; Gasket on Pump Gland Seal Exhaust Condenser Failed, December 22, 1972; HPCI Steamline High Differential Pressure Switch Reset, December 19, 1972. (Vermont Yankee Nuclear Power Corp., Rutland). 28 Dec 1972. 9p. Dep. NTIS.

14109 (DOCKET-50271–129) VERMONT YANKEE NUCLEAR POWER STATION. Technical Specifications, Change 5. (Directorate of Licensing (AEC), Washington, D. C.). 3 Jan 1973. 5p. Dep. NTIS.

Revised technical specifications are presented concerning a temporary increase in radioactive effluent release limits. (D.C.C.)

14110 (DOCKET-50271-131) VERMONT YANKEE NUCLEAR POWER STATION. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection on September 13-15, and 26, 1972. (Vermont Yankee Nuclear Power Corp., Rutland). 6 Nov 1972. 18p. Dep. NTIS.

14111 (DOCKET-50271-132) VERMONT YANKEE NUCLEAR POWER STATION. HPCI Inverter Tripped. (Vermont Yankee Nuclear Power Corp., Rutland). 3 Jan 1973. 2p. Dep. NTIS.

14112 (DOCKET-50280-101) SURRY POWER STATION, UNITS 1 AND 2. Hydrogen Recombiner Installed on Unit 1 and Recombiner for Unit 2 Being Prepared for Testing. (Virginia Electric and Power Co., Richmond). 5 Jan 1973. 1p. (DOCKET-50281-81). Dep. NTIS.

14113 (DOCKET-50282-86) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Limitorque Valve Operator Failures. (Northern States Power Co., Minneapolis, Minn.). 20 Dec 1972. 2p. (DOCKET-50306-82). Dep. NTIS.

14114 (DOCKET-50285-81) FORT CALHOUN STATION, UNIT 1. Limitorque Operators. (Omaha Public Power District, Nebr.). 12 Jan 1973. 6p. Dep. NTIS.

14115 (DOCKET-50293-109) PILGRIM NUCLEAR POWER STATION. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection of September 27-29, 1972 and October 10-12, 1972. (Boston Edison Co., Mass.). 22 Nov 1972. 25p. Dep. NTIS.

Additional information is presented concerning noncompliance to technical specifications for reactor operations. (D.C.C.)

14116 (DOCKET-50293-110) PILGRIM NUCLEAR POWER STATION. Drift of Setpoints on Pressure Switches, December 22, 1972 and December 23, 1972; Loss of Turbine Oil Pressure, December 30, 1972. (Boston Edison Co., Mass.). 31 Dec 1972. 3p. Dep. NTIS.

14117 (DOCKET-50309-65) MAINE YANKEE ATOMIC POWER STATION. Monthly Report 10-72, October 1972. (Maine Yankee Atomic Power Co., Westboro, Mass.). 28 Dec 1972. 25p. Dep. NTIS.

14118 (DOCKET-50331-72) DUANE ARNOLD ENERGY CENTER. Application for Licenses, Amendment 10-A. (Iowa Electric Light and Power Co., Cedar Rapids). 26 Dec 1972. 177p. Dep. NTIS.

Financial data on the owners of the Duane Arnold Power Reactor are presented. The 1971 Annual Reports are included for the Central Iowa Power Cooperative, the Corn Belt Power Cooperative, and the Iowa Electric Light and Power Company. (D.C.C.)

14119 (DOCKET-50409-31) LA CROSSE BOILING WATER REACTOR. Reactor Vessel Heatup Rate in Excess of the Technical Specification Limit. Unplanned Reactor Shutdown. (Dairyland Power Cooperative, La Crosse, Wis.). 27 Dec 1972. 9p. Dep. NTIS.

14120 (NP-19476, pp 50-78) ROLE OF THE ENGINEER IN EVALUATING VARIOUS NUCLEAR POWER PLANT TYPES. Baron, S. (Burns and Roe Inc., Oradell, NJ). 9 Dec 1971.

The tasks of the architect-engineering company in the evaluation of a proposed nuclear power plant are discussed. Following consideration of contract types and bids, the evaluation of bids is discussed with special reference to completeness of bids, price data, guarantees, operating costs, and instrumentation and computer systems. Balances of plant costs are described. Finally fuel cycle services and economics are discussed in some detail. (Norway)

14121 (WASH-1208(12-72)) STATUS OF CENTRAL STATION NUCLEAR POWER REACTORS SIGNIFICANT MILESTONES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 1 Dec 1972. 10p. Dep. NTIS.

Significant data on U.S. power reactor owners, architect-engineers, and dates of construction and operation are tabulated. (HDR)

14122 CONCLUSIONS TO BE DRAWN WHEN PLANNING NEW INSTALLATIONS FROM SEVERAL YEARS' EXPERIENCE WITH A BOILING-WATER REACTOR. Deublein, Otmar (Kernkraftwerk GmbH, Lingen, Ger.). At. Strom; 18: No. 9-10, 118-22(1972). (In German).

The operation of a nuclear power station for several years gives experience and data which should be used as far as possible for new installations. Attention is drawn to headings of experience in the Lingen nuclear power station which have led to proposals which may result in improvement in operation, an increase in availability, and facilitation in operation and maintenance resulting in lower costs in new installations. Further, arrangements for radiation protection can be improved in some cases. In addition, continuous and comprehensive exchange of experience is desirable between operation and planning of a nuclear power station. (auth)

14123 REACTOR CONSTRUCTION: 1300 MWe AEG BOILING WATER REACTOR. Nucleus (Bonn); 18: No. 5-6, 35-8(1972). (In German).

The two German utilities HEW (Hamburgische Electricitaets-Werke) and NWK (Nordwestdeutsche Kraftwerke) are planning to use an AEG boiling-water reactor for the 1316 MW(e) nuclear power station Kruemmel. The characteristic features of this AEG boiling-water reactor line which was initiated in 1969 with Brunsbuettel station are the depressurizing system and the coolant circulation within the reactor pressure vessel by means of internal axial pumps. Typical data for a 1316 MW(e) AEG-BWR are presented. Since all important design criteria are maintained, many components can be used for the whole series. The number of standard components used for the 800 MW station is compared with those for the 900 MW and the 1300 MW station. (GF)

14124 REACTOR CONSTRUCTION: SODIUM-COOLED FAST BREEDER REACTOR SNR-300. Nucleus (Bonn); 18: No. 11, 91-5(1972). (In German).

The development of the project, the contracting parties and participants in the project, and the expected costs are reported. (GF)

14125 PROBLEMS IN THE OPERATING EXPERIENCE OF TSURUGA NUCLEAR PLANT. Hamazaki, Kazunari (Japan Atomic Power Co., Tsuruga, Japan). Karyoku Hatsuden; 23: No. 1, 28-32(Jan 1972). (In Japanese).

Operating experience at the Tsuruga nuclear plant is discussed. In periodic inspections in addition to conventional tests on valves for the turbine, tests on safety equipment are involved. A radiation protection system was adopted for working under radiation and for repairing equipment. A fuel management system was established, and was successfully used. The management system for handling of in-core fuel is not yet successful. Control of core performance is performed by specialists. It is desirable that the management of power stations of the same type be performed by a centralized and unified control system. Water for the reactor is controlled as to electric conductivity and concentration of chlorine ions and insoluble materials. Methods for radioactive waste processing were revised. The handling of liquid radioactive wastes includes waste generation, treatment, and storage. Waste sources include floor drainage, machine drainage, and high electric conductivity drainage. Processing of these wastes is being studied. It is hoped that a final treatment method for filter sludge will be developed. (Japan)

Safety and Siting

Refer also to abstracts 11974 and 12316.

14126 (DOCKET-1151-61) ELK RIVER REACTOR. Steps Taken to Correct Item of Noncompliance Brought to Attention in Letter Dated December 4, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 4 Dec 1972. 20p. Dep. NTIS.

Additional information is presented concerning activities that are in noncompliance with the dismantling plan. (DCC)

14127 (DOCKET-50003-150) INDIAN POINT STATION, UNIT 1. Technical Specifications, Request for Additional Information, Meteorology. (Directorate of Licensing (AEC), Washington, D. C.). 28 Nov 1972. 2p. Dep. NTIS.

14128 (DOCKET-50133-102) HUMBOLDT BAY POWER PLANT, UNIT 3. Fuel Densification Effects. (Pacific Gas and Electric Co., San Francisco, Calif.). 4 Jan 1973. 2p. Dep. NTIS.

14129 (DOCKET-50133-103) HUMBOLDT BAY POWER PLANT, UNIT 3. License No. DPR-7, Change 42. (Directorate of Licensing (AEC), Washington, D. C.). 14 Dec 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the inspection requirements for the containment system suppression chamber following a safety valve discharge. (D.C.C.)

14130 (DOCKET-50155-134) BIG ROCK POINT NUCLEAR PLANT. PALISADES PLANT. Valve Wall Thickness. (Con-

sumers Power Co., Jackson, Mich.). 9 Nov 1972. 5p. (DOCKET-50255-123). Dep. NTIS.

14131 (DOCKET-50155-136) BIG ROCK POINT NUCLEAR PLANT. PALISADES PLANT. Information Regarding Limitorque Valve Operator. (Consumers Power Co., Jackson, Mich.). 8 Jan 1973. 1p. (DOCKET-50255-128). Dep. NTIS.

14132 (DOCKET-50206-178) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Fuel Densification Effects. (Southern California Edison Co., Rosemead, Calif.). 27 Nov 1972. 2p. Dep. NTIS.

14133 (DOCKET-50219-225) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Application For Full Term License, Supplement 3. (Jersey Central Power and Light Co., Morristown, N. J.). 9 Jan 1973. 4p. Dep. NTIS.

Additional information is presented concerning the reactor building crane. (DCC)

14134 (DOCKET-50220-118) NINE MILE POINT NUCLEAR STATION, UNIT 1. Fuel Densification Effect. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 3 Jan 1973. 3p. Dep. NTIS.

14135 (DOCKET-50220-119) NINE MILE POINT NUCLEAR STATION, UNIT 1. Proposed Change, Access Platform to be Added. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 11 Jan 1973. 7p. Dep. NTIS.

Revised technical specifications are presented concerning the addition of an access platform to the refueling bridge structure to expedite refueling operations. (DCC)

14136 (DOCKET-50237-289) DRESDEN NUCLEAR POWER STATION, UNIT 2. Snap-Lock Limit Switches. (Commonwealth Edison Co., Chicago, Ill.). 4 Jan 1973. 1p. Dep. NTIS.

14137 (DOCKET-50245-179) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Analysis of Relief Valve Discharge Piping and Main Safety Valve Piping. (Millstone Point Co., Hartford, Conn.). 20 Nov 1972. 162p. Dep. NTIS.

14138 (DOCKET-50245-182) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Chloride Intrusion Incident, Revisions. (Millstone Point Co., Hartford, Conn.). 12 Jan 1973. 66p. Dep. NTIS.

Additional information is presented concerning the effects of salt water on control rods and B_4C filled absorber rods. Examination results are included. (DCC)

14139 (DOCKET-50245-183) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Fuel Densification Effect. (Millstone Point Co., Hartford, Conn.). 29 Dec 1972. 1p. Dep. NTIS.

14140 (DOCKET-50247-88) INDIAN POINT NUCLEAR GENERATING UNIT 2. Potential Adverse Effects on Safety Related Equipment Caused by Failure of Non-Seismically Designed Equipment. (Consolidated Edison Co. of New York, Inc., New York). 18 Dec 1972. 4p. Dep. NTIS.

14141 (DOCKET-50247-89) INDIAN POINT NUCLEAR GENERATING UNIT 2. Order Extending Completion Date to March 1, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 27 Dec 1972. 3p. Dep. NTIS.

14142 (DOCKET-50250-110) TURKEY POINT PLANT, UNITS 3 AND 4. Fire Main Riser Found in Switchgear Room is Being Rerouted. (Florida Power and Light Co.). 5 Jan 1973. 1p. (DOCKET-50251-91). Dep. NTIS.

14143 (DOCKET-50255-129) PALISADES PLANT. Steps Taken to Correct Item of Noncompliance Brought to Attention in Letter Dated November 17, 1972. (Consumers Power Co., Jackson, Mich.). 15 Dec 1972. 20p. Dep. NTIS.

Information is presented concerning the absence of protective covers over air solenoid valves for control of main steam isolation valves. (DCC)

14144 (DOCKET-50259-73) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Safety Evaluation, Supplement 1. (Directorate of Licensing (AEC), Washington, D. C.). 21 Dec 1972. 69p. (DOCKET-50260-69; DOCKET-50296-67). Dep. NTIS.

14145 (DOCKET-50261-133) H. B. ROBINSON UNIT 2. Technical Specification Change for Test Fuel Assemblies. (Carolina Power and Light Co., Raleigh, N. C.). 5 Jan 1973. 15p. Dep. NTIS.

14146 (DOCKET-50261-136) H. B. ROBINSON UNIT 2. Environmental Report, Supplement 1. (Carolina Power and Light Co., Raleigh, N. C.). 15 Jan 1973. 137p. Dep. NTIS.

14147 (DOCKET-50263-167) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Technical Specifications, Change 4. (Directorate of Licensing (AEC), Washington, D. C.). 8 Dec 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the routine testing schedule for the main steam line isolation valves. (D.C.C.)

14148 (DOCKET-50263-169) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Fuel Densification Effects. (Northern States Power Co., Minneapolis, Minn.). 29 Dec 1972. 8p. Dep. NTIS.

14149 (DOCKET-50263-170) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Steps Taken to Correct Items of Noncompliance Brought to Attention in Letter Dated October 19, 1972. (Northern States Power Co., Minneapolis, Minn.). 18 Dec 1972. 28p. Dep. NTIS.

Additional information is presented concerning operating procedures, personnel training program, instrument maintenance, and the residual heat removal system. (DCC)

14150 (DOCKET-50263-171) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Support Hangers for Emergency Core Cooling System Suction Header. (Northern States Power Co., Minneapolis, Minn.). 6 Dec 1972. 2p. Dep. NTIS.

14151 (DOCKET-50266-95) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Comments on Simultaneous Actuation of a Safety Injection Signal on Both Units of a Dual Unit Facility. (Wisconsin Electric Power Co., Milwaukee). 11 Dec 1972. 4p. (DOCKET-50301-80). Dep. NTIS.

14152 (DOCKET-50269-84) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Installation of Flow Restrictors in Core Flooding Nozzles. (Duke Power Co., Charlotte, N. C.). 12 Jan 1973. 66p. (DOCKET-50270-70; DOCKET-50287-62). Dep. NTIS.

14153 (DOCKET-50271-126) VERMONT YANKEE NUCLEAR POWER STATION. Fuel Densification Effects. (Vermont Yankee Nuclear Power Corp., Rutland). 3 Jan 1973. 1p. Dep. NTIS.

14154 (DOCKET-50271-133) VERMONT YANKEE NUCLEAR POWER STATION. Technical Specifications, Change 4. (Directorate of Licensing (AEC), Washington, D. C.). 10 Jan 1973. 6p. Dep. NTIS.

Revised technical specifications are presented concerning responsibilities of the state advisory group for environmental aspects of reactor operation. (DCC)

14155 (DOCKET-50271-134) VERMONT YANKEE NUCLEAR POWER STATION. Facility Operating License DPR-28, Amendment 4. (Directorate of Licensing (AEC), Washington, D. C.). 8 Jan 1973. 4p. Dep. NTIS.

Information is presented concerning the revised possession limit for ^{235}U to 3300 kilograms. (DCC)

14156 (DOCKET-50272-46) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 17. (Public Service Electric and Gas Co., Newark, N. J.). 18 Dec 1972. 98p. (DOCKET-50311-47). Dep. NTIS.

Revised and requested data are presented concerning safety analysis, containment system, radioactive effluents, and auxiliary power system. (D.C.C.)

14157 (DOCKET-50275-29) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Design Deficiency in Concrete Walls. (Pacific Gas and Electric Co., San Francisco, Calif.). 20 Nov 1972. 3p. (DOCKET-50323-27). Dep. NTIS.

14158 (DOCKET-50275-30) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Fuel Densification Effect. (Pacific Gas and Electric Co., San Francisco, Calif.). 3 Jan 1973. 2p. (DOCKET-50323-28). Dep. NTIS.

14159 (DOCKET-50277-71) PEACH BOTTOM ATOMIC POWER STATION, UNIT 2. Significant Deficiency Interim Report Concerning Main Steam Line Restraints. (Philadelphia Electric Co., Pa.). 7 Dec 1972. 3p. Dep. NTIS.

14160 (DOCKET-50277-72) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Radioactive Effluent Limits. (Philadelphia Electric Co., Pa.). 4 Jan 1973. 3p. (DOCKET-50278-70). Dep. NTIS.

14161 (DOCKET-50277-73) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Fuel Densification Effect. (Philadelphia Electric Co., Pa.). 3 Jan 1973. 1p. (DOCKET-50278-71). Dep. NTIS.

14162 (DOCKET-50280-99) SURRY POWER STATION, UNIT 1. Request Review of Fuel Densification Report be Expedited. (Virginia Electric and Power Co., Richmond). 21 Dec 1972. 3p. Dep. NTIS.

14163 (DOCKET-50280-100) SURRY POWER STATION, UNITS 1 AND 2. Technical Specifications, Revision No. 4, Recommended Changes. (Virginia Electric and Power Co., Richmond). 29 Dec 1972. 13p. (DOCKET-50281-80). Dep. NTIS.

14164 (DOCKET-50282-85) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Request for Extension of Latest Dates of Completion. (Northern States Power Co., Minneapolis, Minn.). 28 Dec 1972. 3p. (DOCKET-50306-81). Dep. NTIS.

14165 (DOCKET-50282-87) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 27. (Northern States Power Co., Minneapolis, Minn.). 20 Dec 1972. 111p. (DOCKET-50306-83). Dep. NTIS.

Additional information is presented concerning the site, safety analysis, radioactive effluents, auxiliary systems, electrical systems, engineered safeguards, containment system, and cooling system. (DCC)

14166 (DOCKET-50285-79) FORT CALHOUN STATION, UNIT 1. Failure of Non-Category I (Seismic) Equipment Effect on Other Safety Related Equipment. (Omaha Public Power District, Nebr.). 19 Oct 1972. 2p. Dep. NTIS.

14167 (DOCKET-50285-80) FORT CALHOUN STATION, UNIT 1. Order Extending Completion Date to June 31, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 27 Dec 1972. 3p. Dep. NTIS.

14168 (DOCKET-50285-82) FORT CALHOUN STATION, UNIT 1. Inspections of November 3, 1972 and November 20, 1972. (Omaha Public Power District, Nebr.). 24 Nov 1972. 39p. Dep. NTIS.

14169 (DOCKET-50286-57) INDIAN POINT NUCLEAR GENERATING UNIT 3. Final Facility Description and Safety Analysis Report, Supplement 9. (Consolidated Edison Co. of New York, Inc., New York). 12 Jan 1973. 358p. Dep. NTIS.

Revised and requested data are presented concerning core physics, cooling system, structures, power conversion system, radioactive waste disposal, personnel, and technical specifications. (DCC)

14170 (DOCKET-50286-58) INDIAN POINT NUCLEAR GENERATING UNIT 3. Action to be Taken to Correct Item of Noncompliance Brought to Attention Following Inspection on October 26, 1972. (Consolidated Edison Co. of New York, Inc., New York). 29 Nov 1972. 11p. Dep. NTIS.

Information is presented concerning construction procedures and cleanliness of the pressure vessel during construction. (DCC)

14171 (DOCKET-50286-59) INDIAN POINT NUCLEAR GENERATING UNIT 3. Fuel Densification Effects. (Consolidated Edison Co. of New York, Inc., New York). 9 Jan 1973. 2p. Dep. NTIS.

14172 (DOCKET-50286-60) INDIAN POINT NUCLEAR GENERATING UNIT 3. Reinspection and Appraisal of the Indian Point No. 3 Reactor Pressure Vessel Subsequent to Hoist Failure on January 12, 1971. (Oak Ridge National Lab., Tenn.). Oct 1972. 66p. Dep. NTIS.

For Consolidated Edison Co. of New York, Inc., New York.

14173 (DOCKET-50289-83) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Quality Assurance Program. (Metropolitan Edison Co., Reading, Pa.). 14 Dec 1972. 38p. (DOCKET-50320-39). Dep. NTIS.

14174 (DOCKET-50289-84) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Errors in Inspection Report. (Metropolitan Edison Co., Reading, Pa.). 4 Dec 1972. 16p. Dep. NTIS.

14175 (DOCKET-50289-85) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Defects in Shop Welds of Coolant Piping. (Metropolitan Edison Co., Reading, Pa.). 8 Dec 1972. 4p. Dep. NTIS.

14176 (DOCKET-50289-86) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Action to be Taken to Correct Items of Noncompliance Brought to Attention Following Inspection of October 20, 1972. (Metropolitan Edison Co., Reading, Pa.). 20 Nov 1972. 17p. Dep. NTIS.

Additional information is presented concerning the preoperational test program. (DCC)

14177 (DOCKET-50289-87) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Action Taken to Correct Item of Noncompliance Which was Brought to Attention Following Inspection of September 25-27, 1972. (Metropolitan Edison Co., Reading, Pa.). 1 Dec 1972. 14p. (DOCKET-50320-40). Dep. NTIS.

Additional information is presented concerning the possible chloride contamination of the cooling system. (DCC)

14178 (DOCKET-50295-76) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Steps Taken to Correct Items of Noncompliance Brought to Attention in Letter of October 16, 1972. (Commonwealth Edison Co., Chicago, Ill.). 15 Nov 1972. 41p. (DOCKET-50304-73). Dep. NTIS.

Additional information is presented concerning construction activities that are not in conformance with engineering specifications. (D.C.C.)

14179 (DOCKET-50298-61) COOPER NUCLEAR STATION. Fuel Densification Effect. (Nebraska Public Power District, Columbus). 28 Dec 1972. 1p. Dep. NTIS.

14180 (DOCKET-50301-79) POINT BEACH NUCLEAR PLANT, UNIT 2. Fuel Densification Effect. (Wisconsin Electric Power Co., Milwaukee). 3 Jan 1973. 2p. Dep. NTIS.

14181 (DOCKET-50302-60) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Final Safety Analysis Report, Amendment 23. (Florida Power Corp., St. Petersburg). 27 Dec 1972. 155p. Dep. NTIS.

Information is presented concerning the effects of a hurricane on the reactor site and safety aspects of reactor operation. (D.C.C.)

14182 (DOCKET-50305-62) KEWAUNEE NUCLEAR POWER PLANT. Safety Evaluation, Supplement 1. (Directorate of Licensing (AEC), Washington, D. C.). 18 Dec 1972. 23p. Dep. NTIS.

14183 (DOCKET-50305-63) KEWAUNEE NUCLEAR POWER PLANT. Order Extending Construction Completion Date to August 31, 1973. (Directorate of Licensing (AEC), Washington, D. C.). 27 Dec 1972. 3p. Dep. NTIS.

14184 (DOCKET-50305-64) KEWAUNEE NUCLEAR POWER PLANT. Fuel Densification Effect. (Wisconsin Public Service Corp., Green Bay). 29 Dec 1972. 2p. Dep. NTIS.

14185 (DOCKET-50313-61) ARKANSAS NUCLEAR ONE, UNIT 1. Steps Taken to Correct Items of Noncompliance Brought to Attention in Letter of October 19, 1972. (Arkansas Power and Light Co., Little Rock). 15 Dec 1972. 11p. Dep. NTIS.

Additional information is presented concerning preoperational testing requirements. (D.C.C.)

14186 (DOCKET-50315-93) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Report of Investigation Into Tube Failure and Corrective Action Taken. (American Electric Power Service Corp., New York). 22 Dec 1972. 10p. (DOCKET-50316-93). Dep. NTIS.

Information is presented concerning tube failures in heat exchangers of the component cooling system. (D.C.C.)

14187 (DOCKET-50317-76) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 32. (Baltimore Gas and Electric Co., Md.). 5 Jan 1973. 34p. (DOCKET-50318-73). Dep. NTIS.

Revised and additional data are presented concerning the main steam line isolation valves, engineered safeguards, and the steam supply system. (D.C.C.)

14188 (DOCKET-50321-64) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Reactor Vessel Repair, Additional Information. (Georgia Power Co., Atlanta). 21 Dec 1972. 6p. Dep. NTIS.

14189 (DOCKET-50331-71) DUANE ARNOLD ENERGY CENTER. Main Steam Line Surface Defect. (Iowa Electric Light and Power Co., Cedar Rapids). 5 Dec 1972. 3p. Dep. NTIS.

14190 (DOCKET-50333-74) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Fuel Densification Effects. (Power Authority of the State of New York). 2 Jan 1973. 1p. Dep. NTIS.

14191 (DOCKET-50336-48) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 2. Reactor Coolant Boundary Valves 1-1/4" and Larger. (Millstone Point Co., Hartford, Conn.). 27 Dec 1972. 3p. Dep. NTIS.

14192 (DOCKET-50344-35) TROJAN NUCLEAR PLANT. Fuel Densification Effect. (Portland General Electric Co., Oreg.). 27 Dec 1972. 2p. Dep. NTIS.

14193 (DOCKET-50344-36) TROJAN NUCLEAR PLANT. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Jan 1973. 301p. Dep. NTIS.

The environmental effects of construction and operation of the Trojan Power Reactor Unit 1 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits–cost analysis of the proposed plant operation. (D.C.C.)

14194 (DOCKET-50363-43) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Fuel Densification Effect. (Jersey Central Power and Light Co., Morristown, N. J.). 3 Jan 1973. 6p. Dep. NTIS.

14195 (DOCKET-50366-35) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Construction Permit No. CPPR-90. (Directorate of Licensing (AEC), Washington, D. C.). 27 Dec 1972. 5p. Dep. NTIS.

14196 (DOCKET-50369-33) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Fuel Densification Effects. (Duke Power Co., Charlotte, N. C.). 3 Jan 1973. 2p. (DOCKET-50370-33; DOCKET-50413-8; DOCKET-50414-8). Dep. NTIS.

14197 (DOCKET-50369-34) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Revision 11. (Duke Power Co., Charlotte, N. C.). 28 Dec 1972. 4p. (DOCKET-50370-34). Dep. NTIS.

Additional information is presented concerning the containment system and the residual heat removal system isolation valves. (DCC)

14198 (DOCKET-50373-30) LA SALLE COUNTY STATION, UNITS 1 AND 2. No Need for an Antitrust Hearing. (Department of Justice, Washington, D. C. Antitrust Div.). 20 Dec 1972. 21p. (DOCKET-50374-29). Dep. NTIS.

14199 (DOCKET-50373-31) LA SALLE COUNTY STATION, UNITS 1 AND 2. Release of Information on Lake Sangchris, Ill. (Commonwealth Edison Co., Chicago, Ill.). 3 Jan 1972. 2p. (DOCKET-50374-30). Dep. NTIS.

Additional information is presented concerning insecticide levels in bottom sediments of Lake Sangchris. (DCC)

14200 (DOCKET-50376-36) AGUIRRE NUCLEAR PLANT, UNIT 1. Preliminary Facility Description and Safety Analysis Report, Amendment 19. (Puerto Rico Water Resources Authority, San Juan). 5 Jan 1973. 44p. Dep. NTIS.

Revised and additional data are presented concerning the reactor site, cooling system, control system, and earthquake stress analysis for equipment and structures. (D.C.C.)

14201 (DOCKET-50382-48) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Steps Taken to Correct Item of Noncompliance Brought to Attention in Letter of November 30, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 30 Nov 1972. 8p. Dep. NTIS.

Information is presented concerning activities that are in noncompliance with the quality assurance program requirements. (DCC)

14202 (DOCKET-50382-49) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Fuel Densification Effects. (Louisiana Power and Light Co., New Orleans). 2 Jan 1973. 7p. Dep. NTIS.

14203 (DOCKET-50390-32) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Fuel Densification Effects. (Tennessee Valley Authority, Chattanooga). 29 Dec 1972. 2p. (DOCKET-50391-32). Dep. NTIS.

14204 (DOCKET-50395-35) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Foundation Work and Buildings. (South Carolina Electric and Gas Co., Columbia). 21 Dec 1972. 2p. Dep. NTIS.

Additional information is presented concerning effects of earthquake stresses on structures. (DCC)

14205 (DOCKET-50397-36) HANFORD NO. 2 NUCLEAR POWER PLANT. Fuel Densification Effects. (Washington Public Power Supply System, Richland). 2 Jan 1973. 2p. Dep. NTIS.

14206 (DOCKET-50398-29) MENDOCINO POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 19. (Pacific Gas and Electric Co., San Francisco, Calif.). 27 Dec 1972. 32p. (DOCKET-50399-29). Dep. NTIS.

Revised and requested data are presented concerning auxiliary systems, electrical systems, containment system, structures, instrumentation, and earthquake response spectra for the site. (DCC)

14207 (DOCKET-50400-33) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). 22 Dec 1972. 183p. (DOCKET-50401-33; DOCKET-50402-33; DOCKET-50403-34). Dep. NTIS.

14208 (DOCKET-50404-33) NORTH ANNA POWER STATION, UNITS 3 AND 4. Service Reservoir Volume. (Virginia Electric and Power Co., Richmond). 29 Dec 1972. 4p. (DOCKET-50405-33). Dep. NTIS.

14209 (DOCKET-50410-18) NINE MILE POINT NUCLEAR STATION, UNIT 2. Fuel Densification Effects. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 3 Jan 1973. 1p. Dep. NTIS.

14210 (DOCKET-50416-12) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Fuel Densification Effects. (Mississippi Power and Light Co., Jackson (USA)). 2 Jan 1973. 4p. (DOCKET-50417-12). Dep. NTIS.

14211 (DOCKET-50416-13) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Amendment 1. (Mississippi Power and Light Co., Jackson (USA)). 21 Dec 1972. 72p. (DOCKET-50417-13). Dep. NTIS.

14212 (DOCKET-50416-14) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Mississippi Power and Light Co., Jackson (USA)). 21 Dec 1972. 460p. (DOCKET-50417-14). Dep. NTIS.

Revised and additional data are presented concerning engineered safeguards, reactor site, structures, containment system, emergency systems, instrumentation, electrical systems, auxiliary systems, radioactive waste disposal, and personnel. (DCC)

14213 (DOCKET-RESARA-15) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, RESAR-3, Amendment 2, Revision 3. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Dec 1972. 138p. Dep. NTIS.

Requested additional data are presented concerning the safety analysis, emergency core cooling system, instrumentation, and cooling system. (D.C.C.)

14214 (FIND-50269(12-72)) FIND: OCONEE NUCLEAR STATION UNITS 1, 2, AND 3. Gamble, R. L. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 14 Dec 1972. 47p. (FIND-50270(12-72); FIND-50287(12-72)). Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (DCC)

14215 (NP-19476, pp 25-49) SOME ENVIRONMENTAL ASPECTS OF NUCLEAR POWER. Dunster, H. J. (National Radiological Protection Board, Harwell, Eng.). 9 Nov 1971.

Following a brief discussion of the background for the ICRP recommendations for dose limits for the exposure of the general public to radiation, the practical application of waste management principles in Britain is discussed. Liquid wastes from nuclear power stations are discharged to coastal or estuarine waters. In the future increasing throughput in factories concerned with the fuel cycle will lead to increased requirements for the safe disposal of low activity and high activity solid wastes. Krypton 85 releases are also considered and found within safe limits. Marine disposal is discussed but is stated to be relatively expensive, though highly satisfactory otherwise. It is suggested that the main ecological aspect of nuclear power is that it provides the basis for solving our ecological problems. (Norway)

14216 (NP-19476, pp 79-104) SITING QUESTIONS FOR NUCLEAR POWER PLANTS. Mandel, H. (Rheinisch-Westfaelisches Elektricitaetswerk A.G., Essen). 1 Feb 1972. (In German).

Nuclear power plants must be safe whatever their location. Fundamentally, therefore, there is no siting criterion in plant

safety. Hence, since no distinction between rural and urban location is apparent, the same siting criteria must be applied to nuclear power plants as to conventional plants. Those factors on which the decision on plant site are based may mainly be placed in two groups. The primary group fixes the general location and depends mainly on the primary purpose of the plant. The secondary group gives a more precise location and raises economic optimization aspects and decisions based on local conditions. (auth)

14217 (ORNL-tr-2647) GERMAN RESEARCH PROGRAM ON REACTOR SAFETY. Translated for Oak Ridge National Lab., Tenn., from Atomwirt., Atomtech.; 17: 494-6(1972). 8p. Dep. NTIS.

14218 (RDT-INDEX-11-72) INDEX OF RDT STANDARDS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Nov 1972. 30p. RSO.

This bimonthly index is the current listing of 256 RDT Standards issued through November 30, 1972. (auth)

14219 (WASH-1198(1970)) REPORT ON RELEASES OF RADIOACTIVITY FROM POWER REACTORS IN EFFLUENTS DURING 1970. (Division of Compliance (AEC), Washington, D. C.). Oct 1971. 9p. Dep. NTIS.

A tabulation of radioactivity released in effluents from operating nuclear power plants during 1970 is presented. The radioactivity in effluent releases from licensed power reactors has been generally low in comparison with the permissible limits under the Atomic Energy Commission's Part 20 of Title 10, Chapter 1, Code of Federal Regulations, "Standards for Protection Against Radiation." (auth)

14220 RHINE BETWEEN KARLSRUHE AND MANNHEIM AS DISTRICT FOR REACTOR SITES UNDER THE ASPECT OF INDIVIDUAL AND POPULATION FACTORS. Bayer, A. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie; 20: No. 1, 65-70(Sep 1972). (In German).

Regarding atmospheric dispersion, the Upper Rhine between Karlsruhe and Mannheim is considered as an appropriate district for reactor sites. Sources are placed along the river at a distance of 1 km. The individual and population dispersion factors dependent on the direction of the wind are calculated. Results are presented and discussed with emphasis on the two sites of Philippsburg and Ludwigshafen–BASF. It is shown that the population dispersion factor of Ludwigshafen–BASF is about 10 times higher than that of Philippsburg. (auth)

14221 NUCLEAR POWER PLANT SAFETY SYSTEMS. Lezer, G. (Electricite de France, Paris). Sci. Progr. Decouverte; No. 3447, 13-19(Sep 1972). (In French).

Safety problems concerning PWR plants are analyzed. The various techniques utilized to ensure the safety of the inhabitants living in the area surrounding the Fessenheim plant are presented: control of the level of reactivity, thermal behavior studies, waste product storage, environmental studies, and the use of special safety devices in the event of an accident. (France)

14222 GROUND CONSTRUCTION WORKS OF SHIMANE ATOMIC POWER STATION. Ebisu, Satoru (Chugoku Electric Power Co. Inc., Hiroshima). Doboku Seko; 13: No. 2, 33-42 (Feb 1972). (In Japanese).

Shimane Atomic Power-Station has been under construction since 1968 at a coastal site north of Matsu with an area of 120,000 m^2, and is approximately 70% completed. The site construction, including embankment works, is a most important part of the construction, as the ground must withstand severe erosion by the Sea of Japan. The site construction requires site development, foundation for a power plant, coast works, and facilities for introducing and discharging water. All construction and machine equipment is listed, and the construction schedule is shown. The geologic profile at the power plant site consists mainly of Tertiary formation with tuffaceous and igneous rocks. The construction of embankments and channels for introducing and discharging water is described. (auth)

14223 USE FLOW CHARTING FOR BETTER TEST PROCEDURES. Stephens, J. V. (Gibbs and Hill, Inc., New York). Power Eng.; 76: No. 9, 34-7(Sep 1972).

To ensure that the engineered safety features of a nuclear power plant will operate infallibly, test procedures involving hundreds of steps are required. Flow charting, a technique for programming computers, can be used to keep track of the steps, avoid omissions, and bring out obscure relationships. Examples are given. (DLC)

14224 POWER PLANT COOLING SYSTEMS. Kinsman, G. J. Power Div., Amer. Soc. Civil Eng.; 98: No. PO2, 247-52(Oct 1972).

Types of systems available and proposed with data required from other than engineering sources to insure compliance with environmental regulations covering both nuclear and fossil-fueled plants are discussed. Large quantities of heat for steam condensation must be dissipated to atmosphere requiring considerable quantities of water. Volume of water available, its temperature and quality, meteorological conditions, economics and environmental consequences must be considered in selection of cooling system. Once-through and closed system wet and dry cooling towers, forced and natural draft types using fresh or salt water are available. Environmental regulations require input from many nonengineering disciplines. (auth)

14225 REACTOR CONSTRUCTION: INCIDENTS IN THE OBRIGHEIM POWER REACTOR. Nucleus (Bonn); 18: No. 8, 63(1972). (In German).

An incident which occurred in February 1972 and the causes leading to this incident are reported. (GF)

14226 ISPRA'S CONTRIBUTION TO REACTOR SAFETY. Randles, J. (Commission of the European Communities, Ispra, Italy). Euro-Spectra; 10: No. 4, 105-16(Dec 1971).

Some problems dealing with the safety of fast and water-cooled reactors are analyzed and the researches involved presented as they are being carried on at the Ispra establishment of the Joint Research Centre. They include: direct contact interaction between hot molten uranium dioxide and sodium; dynamic loading of the containment of a fast reactor due to accidental prompt critical excursion; depressurization studies; studies associated with emergency core-cooling systems; reliability; early failure detection; and fracture mechanics and pipe rupture studies. (auth)

14227 NUCLEAR ENERGY LEAST DAMAGING. Luce, C. F. (Consolidated Edison Co. of New York, Inc., New York). Catal. Environ. Qual.; 2, No. 3, 15-17(1972).

The Consolidated Edison Co. remains convinced that nuclear power is environmentally the least damaging of available electricity producing methods. The polluting effects of coal burning facilities and short supply of gas and oil are discussed. Difficulties in meeting projected operational dates for planned nuclear power plants are described. Until new facilities are in operation for meeting power demands, power conservation, improved pollution control in existing facilities, and further research and development of new ways to produce and deliver electricity are recommended. (LCL)

14228 CASE AGAINST NUCLEAR POWER. Gofman, J. W. (Univ. of California, Berkeley). Catal. Environ. Qual.; 2, No. 3, 18-20(1972).

The public health hazards of radioactive materials released to the environment from nuclear power plants are discussed. (LCL)

14229 INSERVICE INSPECTION OF NUCLEAR PLANTS. Sattler, F. J. (Babcock and Wilcox, Copley, Ohio); Forrer, G. R.; Parker, W. O. Jr. Mater. Eval.; 30: No. 11, 18A-22A; 27A-29A(Nov 1972).

Testing methods and techniques for the inservice inspection of materials and equipment in nuclear power plants are discussed and include: visual examination; liquid penetrant methods; magnetic particle inspection; volumetric examination using gamma rays and x rays; and manual and remote automated ultrasonic inspection—particularly of reactor vessels. Further research on automated NDT methods for nuclear power plant components is recommended. (LCL)

Steam and Power Conversion Systems

14230 DETECTION CO_2 LEAK INTO WATER OR STEAM OF STEAM GENERATOR. Melichar, Z.; Sandrik, S. Radioisotopy; 13: No. 4, 849-59(1972). (In Czech).

Based on the experimental verification of two variants measurements of CO_2 leak into water or steam of steam generator and from their evaluation, a method for detection of activity in CO_4 samples, with compensation radiometers, was chosen. The realization of method is in the nuclear power station A-1. (auth)

Propulsion and Auxiliary Power Reactors

14231 (BNL-50362) ROTATING FLUIDIZED BED REACTOR FOR SPACE NUCLEAR PROPULSION. Annual Report: Design Studies and Experimental Results, June 1971–June 1972. Hendrie, J. M.; Hoffman, K. C.; Isler, R. J.; Ludewig, H.; Manning,

A. J.; Suuberg, E.; Miles, F. T.; Raseman, C. J. (Brookhaven National Lab., Upton, N. Y.). Sep 1972. 56p. Dep. NTIS.

The suitability of the rotating fluidized bed reactor concept for nuclear rocket propulsion systems is investigated. A low thrust (90,000 N) rocket engine was optimized with details of the critical mass determination and engine operating conditions included. The investigation of the fluid mechanics of a rotating fluidized bed system was continued. A correlation is given to predict minimum fluidization Reynolds numbers based on particle, fluid, and rotative properties. 20 references. (auth)

14232 (LA-DC-72-1234) DESIGN OF A NUCLEAR ROCKET ENGINE FOR ADVANCED UNMANNED MISSIONS. Durham, F. P.; Kirk, W. L. (Los Alamos Scientific Lab., N. Mex.). [nd]. 10p. (CONF-721116-3). Dep. NTIS.

From 8th propulsion joint specialists conference; New Orleans, LA (29 Nov 1972).

The design of a nuclear rocket engine for unmanned missions to the outer planets and round-trip missions to synchronous orbit is described. The engine design is based on the Los Alamos Pewee reactor and technology from the NERVA program. Engine mass and length are minimized so that the nuclear stage and its payload can be carried into orbit by a single Earth Orbital Shuttle. The basic engine characteristics are: I_{sp}, 875 sec; thrust, 73,000 N; power, 365 MW; mass, 2668 kg; length, 3.16 m; and propellant flow rate, 8.5 kg/sec. (auth)

14233 (LA-DC-72-1255) MISSION PERFORMANCE OF A 360-MW NUCLEAR ROCKET ENGINE. Balcomb, J. D. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 7p. (CONF-721116-2). Dep. NTIS.

From 8th propulsion joint specialists conference; New Orleans, LA (29 Nov 1972).

Mission performance is assessed for a nuclear engine. Classes of missions considered are: (1) unmanned planetary probes representative of early missions, (2) advanced unmanned planetary probes utilizing multiple-module vehicles assembled in orbit, and (3) geocentric missions of reusable vehicles. Important operational characteristics of the nuclear engine are discussed, e.g., startup and shutdown characteristics, cooldown requirements, and propellant utilization. (auth)

14234 (LA-DC-72-1262) NUCLEAR ROCKET ENERGY CENTER CONCEPT. Altseimer, J. H.; Booth, L. A. (Los Alamos Scientific Lab., N. Mex.). 1972. 14p. (CONF-721116-1). Dep. NTIS.

From 8th propulsion joint specialists conference; New Orleans, LA (29 Nov 1972).

The growth potential of the nuclear rocket engine involves multiple uses of the engine reactor (e.g., for propulsion, attitude control, refrigeration, and scientific experiments) so that the reactor becomes the nuclear-energy center for the entire vehicle. Possible energy applications are described. The most important auxiliary function is the use of thermal energy to generate electrical power, called "dual-mode" operation, and technical data are given for such a system as incorporated into the LASL Alpha nuclear engine. An organic Rankine-cycle power level of 10 kW(e) was studied, and levels up to 25 kW(e) are feasible. The system was integrated into an engine-tank module configured for the Space Shuttle cargo bay. Payload radiation doses are configuration- and mission-sensitive and may impose operating constraints. Illustrative outer-planet orbiter missions are described which include the use of the dual-mode power system. A new array of advanced high-thrust engines (LASL Alpha, Beta, and Gamma) and complementary low-thrust electric engines and stages are outlined that could be developed gradually and systematically throughout the 1980s and 1990s. 14 references. (auth)

14235 (PWAC-264) PRELIMINARY ENGINEERING DESIGN REPORT FOR A LITHIUM-COOLED REACTOR EXPERIMENT, FEBRUARY 13, 1959. (Pratt and Whitney Aircraft, Middletown, Conn.). 18 Mar 1959. Contract AT(11-1)-229. 222p. Dep. NTIS.

Declassified 31 Oct 1972.

Experimental work associated with a lithium-cooled reactor and conducted at Pratt & Whitney Aircraft to date has resulted in the following conclusions: no corrosion or mass transport of columbium–1.0% zirconium alloy by lithium is observed in systems operated up to 2000°F, 400°F ΔT; rupture strength of columbium–1.0% zirconium alloy is 8000 psi for 100 hours at 2000°F, a value adequate for reactor design requirements; availability and fabricability of columbium–1.0% zirconium alloy are satisfactory; ceramic fuel elements (UO_2–BeO in molybdenum–0.5% titanium clad) show no damage after irradiation in the Materials Testing Reactor at temperatures up to 1800°F, power densities up to 6 kw/cc, and burnups to 6%; and critical experiment measured 144 kg ^{235}U as compared to predicted 134 kg ^{235}U. Based on this datum, the predicted inventory of the proposed experimental reactor, PWAR-11C, is 120.5 kg. (auth)

14236 (PWAC-371) DESIGN AND TESTING OF COLUMBIUM-1 ZIRCONIUM REACTOR PRESSURE VESSELS. (Pratt and Whitney Aircraft, Middletown, Conn.). 15 Oct 1962. Contract AT(30-1)-2789. 79p. Dep. NTIS.

Declassified 31 Oct 1972.

The design and test programs are described for columbium–1 zirconium pressure vessels for lithium-cooled aircraft reactors. (auth)

14237 (TID-26217) INVESTIGATION OF GASEOUS NUCLEAR ROCKET TECHNOLOGY: SUMMARY TECHNICAL REPORT. Kendall, J. S. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. Contract SNPC-70. 113p. (L-910905-13). Dep. NTIS.

The experimental and theoretical investigations conducted during the period from September 1969 through September 1972 were directed toward obtaining information necessary to determine the feasibility of the full-scale nuclear light bulb engine, and of small-scale nuclear tests involving fissioning uranium plasmas in a unit cell installed in a driver reactor, such as the Nuclear Furnace. A large portion of the research employed the UARL 1.2-MW rf induction heater and dc arc heater in tests designed to simulate many of the problems which are inherent in a full-scale engine. Emphasis was also placed on development of rf simulations of conditions expected in nuclear tests in the Nuclear Furnace. The work under the contract has included investigations of the following: (1) the fluid mechanics and containment characteristics of one-component and two-component vortex flows, both unheated and rf-induction heated; (2) heating of particle-seeded streams by thermal radiation from a dc arc to simulate propellant heating; (3) condensation and separation phenomena for metal-vapor/heated-gas mixtures to provide information for conceptual designs of components of fuel exhaust and recycle systems; (4) the characteristics of the radiant energy spectrum emitted from the fuel region, with emphasis on definition of fuel and buffer-gas region seed systems to reduce the ultraviolet radiation emitted from the nuclear fuel; and (5) the effects of nuclear radiation on the optical transmission characteristics of transparent materials. In addition, analytical studies were conducted to interpret the results of these investigations in terms of the requirements for full-scale engines and in-reactor tests. 110 references. (auth)

14238 (TID-26218) NUCLEAR LIGHT BULB PROPELLANT HEATING SIMULATION USING A TUNGSTEN/ARGON AEROSOL AND RADIATION FROM A DC ARC SURROUNDED BY A SEGMENTED MIRROR CAVITY. Klein, J. F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. Contract SNPC-70. 57p. (L-910900-13). Dep. NTIS.

Experiments were conducted to simulate radiant heating of the propellant stream of a nuclear light bulb engine. As in previous experiments, the primary objective was to obtain high bulk exit temperatures in the flowing simulated propellant stream by absorption of large fractions of the incident thermal radiation. A high-power, vortex-stabilized dc arc within an uncooled fused silica tube was used as the radiant energy source. It was surrounded by a mirror system to increase the radiation incident on the simulated propellant. The 12.7-cm-long by 2.3-cm-wide, diverging-duct test section had a transparent front wall and a reflecting rear wall. The central stream of seeded gas, a tungsten-particle/argon aerosol, had unseeded argon buffer layers on both sides to prevent coating of the duct walls. Arc operating times were approximately 0.5 sec with power levels up to 780 kW. Bulk exit temperatures were measured using a calorimeter downstream of the duct. The maximum simulated propellant bulk exit temperature obtained was 4515°K, compared with 3860°K in previous tests, 3300 to 3700°K expected in in-reactor tests in the Nuclear Furnace, and 6660°K in the reference nuclear light bulb engine. The maximum temperature in these tests was limited primarily by the amount of radiation incident on the test section (determined by the arc operating characteristics and the effectiveness of the mirror cavity). 17 references. (auth)

14239 (TID-26219) SPECTRAL ABSORPTION COEFFICIENTS OF ARGON AND SILICON AND SPECTRAL REFLECTIVITY OF ALUMINUM. Krascella, N. L. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. Contract SNPC-70. 53p. (L-910904-3). Dep. NTIS.

A theoretical investigation was conducted to estimate the spectral properties of argon as a function of pressure, temperature and wave number. The spectral characteristics of the argon buffer gas exert a strong influence on radiative energy transfer in the

Nuclear Furnace in-reactor test configuration of the nuclear light bulb engine. An existing computer program was modified and used to calculate the spectral absorption coefficients of argon at total pressures of 50, 100, 250, 500, 750 and 1000 atm in the temperature interval between 1000 and 30,000°K. At each pressure and temperature, spectral properties were calculated for forty-seven wave numbers in the interval between 1000 and 1,000,000 cm^{-1}. Estimates of the spectral absorption coefficients of silicon were made as part of an evaluation of silicon vapor as a possible buffer-gas seeding agent for the reference nuclear light bulb engine. Existing cross-section data were used to calculate the spectral characteristics of silicon at twenty-four temperatures in the interval between 2000 and 10,000°K. Calculations were made for partial pressures of silicon equal to the vapor pressures up to a temperature of 3700°K and equal to 10 atm above 3700°K. Spectral data for silicon were calculated at twenty-nine wave numbers at each temperature and partial pressure. The spectral and angular dependence of the reflectivity of aluminum was also computed for subsequent use in determining radiative transfer characteristics of both the in-reactor-test configuration and the reference engine configuration. Reflectivities of aluminum were calculated at twenty-three wave numbers between 1000 and 1,000,000 cm^{-1} for six angles of incidence between 0 and 89.9°. 13 references. (auth)

14240 (TID–26220) ANALYTICAL DESIGN AND PERFORMANCE STUDIES OF NUCLEAR FURNACE TESTS OF SMALL NUCLEAR LIGHT BULB MODELS. Latham, T. S.; Rodgers, R. J. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. Contract SNPC-70. 87p. (L–910900-17). Dep. NTIS.

Analytical studies were continued to identify the design and performance characteristics of a small-scale model of a nuclear light bulb unit cell suitable for testing in the Nuclear Furnace reactor. Emphasis was placed on calculating performance characteristics based on detailed radiant heat transfer analyses, on designing the test assembly for ease of insertion, connection, and withdrawal at the reactor test cell, and on determining instrumentation and test effluent handling requirements. In addition, a review of candidate test reactors for future nuclear light bulb in-reactor tests was conducted. 34 references. (auth)

14241 (TID–26222) ANALYTICAL DESIGN AND PERFORMANCE STUDIES OF THE NUCLEAR LIGHT BULB ENGINE. Rodgers, R. J.; Latham, T. S. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. Contract SNPC-70. 78p. (L–910900-16). Dep. NTIS.

Analytical studies were conducted to investigate in detail the heat balance characteristics of the nuclear light bulb engine. Distributions of energy deposition to all engine components from the fission process, conduction and convection, and thermal radiation were considered. Where uncertainties in basic data or heat transfer characteristics were encountered, ranges of heat loads were calculated and reference values were selected. The influence of these heat loads on engine performance, space radiator requirements, and cooling sequence and cooling circuit designs was determined. Reference heat balance conditions were chosen which resulted in an engine with a weight of 37,250 kg (82,000 lb), including a space radiator weight of 5500 kg (12,100 lb); a thrust of 409,000 N (92,000 lb); and a specific impulse of 1870 sec. The space radiator serves a dual purpose—rejection of 118 MW of power from structural components of the system during steady-state operation and rejection of fission product decay heat and sensible heat from bulk moderator and structural components after engine shutdown. The analyses resulted in revisions to the previously reported reference engine characteristics, principally in the heat loads to some engine components and in the cooling sequence. These revisions were incorporated in the engine dynamics digital computer simulation program. No significant changes occurred in the dynamic response of the engine to perturbations in fuel injection rate, reactivity or exhaust nozzle area. 35 references. (auth)

14242 (TID–26223) DEVELOPMENT OF RF PLASMA SIMULATIONS OF IN-REACTOR TESTS OF SMALL MODELS OF THE NUCLEAR LIGHT BULB FUEL REGION. Roman, W. C.; Jaminet, J. F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. 130p. (L–910900-12). Dep. NTIS.

Experiments were conducted to develop test configurations and technology necessary to simulate the thermal environment and fuel region expected to exist in in-reactor tests of small models of nuclear light bulb configurations. Particular emphasis was directed at rf plasma tests of approximately full-scale models of an in-reactor cell suitable for tests in Los Alamos Scientific Laboratory's Nuclear Furnace. The in-reactor tests will involve vortex-stabilized fissioning uranium plasmas of approximately 200-kW power, 500-atm pressure and equivalent black-body radiating temperatures between 3220 and 3510°K. 30 references. (auth)

14243 (TID–26228) CONCEPTUAL DESIGN STUDIES AND EXPERIMENTS RELATED TO CAVITY EXHAUST SYSTEMS FOR NUCLEAR LIGHT BULB CONFIGURATIONS. Kendall, J. S.; Stoeffler, R. C. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. 33p. (L–910900-15). Dep. NTIS.

Analyses were conducted to develop preliminary conceptual designs for exhaust system components for the nuclear light bulb reference engine and for a small Nuclear Furnace in-reactor test model. Experiments were also conducted to study the heat transfer and condensation processes of metal-vapor/heated-gas mixtures flowing into inlets and long ducts. 10 references. (auth)

14244 FRENCH NUCLEAR POLICY: FUEL ELEMENTS FOR LIGHT WATER PLANTS. Grison, E.; Delafosse, J.; Faussat, A. (CEN de Saclay, Gif-sur-Yvette, France). Sci. Progr. Decouverte; No. 3447, 6-12(Sep 1972). (In French).

The fuel elements used in American pressurized water reactors are described. The work undertaken by the CEA in view of acquiring practical experience in the handling of this type of fuel is reviewed. Such work concerned analytical studies of the components, and more generally, the irradiation of entire assemblies in the PAT reactor developed for nuclear submarines. (France)

14245 OPERATOR TRAINING SIMULATOR FOR NUCLEAR SHIP MUTSU. Wada, H. (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 92, 2321-6(Jun 1971). (In Japanese).

Purpose of this simulator is to train crew of Mutsu for the operation of the reactor plant. The outstanding feature of this simulator is that the trainee can feel as if he is actually operating the nuclear ship. Items of the training include: start up, shut down and loaded operation of the reactor plant; and various operations to cope with accidents. The equipment components to be simulated and extent of the simulation are described in detail. For example, the following four modes of reactor status can be selected with switches at trainer's panel: cold stand-by status; hot stand-by status; base load operation; and normal power operation. (Japan)

Process Heat and Desalination Reactors

Refer also to abstract 13938.

14246 REACTOR CONSTRUCTION: PROCESS HEAT FROM NUCLEAR POWER PLANTS (PROMISING DUAL-PURPOSE COMBINATION). Nucleus (Bonn); 18: No. 1-2, 2-4(1972). (In German).

The principle of nuclear process heat generation as well as the present state of the development work are briefly described. (GF)

14247 HIGH-TEMPERATURE REACTORS FOR THE COAL GASIFICATION. Nieder, R. (Arbeitsgemeinschaft Versuchs-Reaktor GmbH, Juelich, Ger.). Braunkohle; 24: No. 5, 159-60 (1972). (In German).

The fundamentals of using process heat for the gasification of coal are briefly outlined. (GF)

Research and Test Reactors

Refer also to abstracts 13483, 13963, 13991, 14240, and 14313.

14248 (ANL/EBR–67) PRELIMINARY DESIGN AND TEST OF A PROPOSED TURBINE-DRIVEN OSCILLATOR FOR EBR-II. Cole, J. H.; Karvinen, J. R.; Price, C. C. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Oct 1972. Contract W-31-109-Eng-38. 31p. Dep. NTIS.

The design and water test of a reaction-turbine-driven rotary oscillator for possible use in EBR-II are described. The water test verified that the new oscillator has a much greater frequency range than that of the existing oscillator rod. Continued development is recommended. Only a 6-in. section rotates during oscillator operation. This would minimize effects of bowing due to temperature differentials and eliminate the resonance problem associated with mechanical oscillator rods. 3 references. (auth)

14249 (BNWL-tr–77) INVESTIGATION OF THE DISTRIBUTION OF CAVITIES OVER THE PERIMETER OF X18H9T STEEL FUEL ELEMENT CANS OF THE BR-5 REACTOR. Rentov, V. F.; Farkhutdinov, K. G.; Ladygin, A. Ya. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from Russian Preprint. 10p. Dep. NTIS.

Results are presented of electron-microscope studies of the development of porosity in varying areas of the perimeter of cans

made of X18H9T steel, in which a peripheral temperature inequality exists. Shown is the presence of irregular expansion over the can perimeter of the fuel element which, obviously, may lead to bending or destruction of the fuel element. (auth)

14250 (CEA-CONF-2040) DETECTION AND MEASURE OF FISSION PRODUCTS AT PEGASE. Desandre-Navarre, C.; Gouirand, J. M.; Manent, G.; Pasdeloup, L.; Vian, M. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). [nd]. 42p. (In French). (CONF-720566-1). Dep. NTIS (U. S. Sales Only).

From 21st meeting of the Euratom Working Groups on Irradiation Facilities; Julich, Germany (4 May 1972).

The experimental loops at Pegase for the testing of reactor fuel elements and their facilities are described. The fuels that can be tested are the metallic-clad U fuel, coated particles for high temperature reactors, and fuel for fast reactors. The methods used for the detection of fission products from ruptured fuels are described. (JSR)

14251 (CEA-CONF-2076) DISAGREEMENT BETWEEN THEORETICAL AND EXPERIMENTAL FISSION YIELDS OF NOBLE GASES FOR FAST NEUTRONS: TEST ON THE FUEL OF THE RAPSODIE REACTOR. Kryger, B. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 9p. (In French). (CONF-720843-4). Dep. NTIS (U. S. Sales Only).

From Panel on the behaviour and chemical state of fission products in irradiated fuel; Vienna, Austria (7 Aug 1972).

Observations made on $(U,Pu)O_2$ fuels irradiated in Rapsodie with a strong gas release showed that the volume of gas released (^{83,84,85,86}Kr and ^{131,132,134,136}Xe) was much higher to the volume calculated of the gases formed. The variation was particularly in evidence in the 11-11-0002 Fortissimo assembly. An experimental balance was made of the concentration of fission gas actually existing. A variation of 16% was found between the measured and calculated values. A recalculation of the combustion rate was in good agreement with experimental values. A recalculation of the fission yields however, showed that this parameter was probably the cause of the variation between experimental and theoretical values. By using a fission yield value between 0.28 and 0.30 a better agreement was obtained. (JSR)

14252 (CEA-R-4404) IRRADIATION DEVICE FOR THE POWER CYCLING OF A FUEL PENCIL WITH A CONSTANT CLADDING TEMPERATURE AND A FAST INTENSE FLUX: ELSA CAPSULE. Breant, Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1972. 47p. (In French). Dep. NTIS (U. S. Sales Only).

Experimental results of a rig intended for pressurized water fuel studies are presented. Many power cycles have been realized at constant temperature and various times. The rig is operating in the core of reactor OSIRIS (high fast flux) at high pressure (160 kg/cm^2). (15 references) (auth)

14253 (EUR-4861) PULSED SOURCE EXPERIMENTS WITH HEAVY WATER MODERATED NATURAL URANIUM LATTICES IN EXPO AND ECO. Birkhoff, G.; Bondar, L.; Hage, W.; Ley, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1972. 38p. Dep. NTIS (U. S. Sales Only).

In 1967 several pulsed source experiments were made at Ispra in the subcritical facility EXPO and the zero power critical reacto. ECO. The aim of these experiments was to study the problems connected with pulsed source reactivity measurements in natural uranium, heavy water moderated reactors, which are mainly characterized by a long generation time as compared with the short living delayed neutron life time. A survey of various experimental and analytical methods applied along with the results of reactivity and generation time measurements in the negative reactivity range between about 0.17 and 40$ is presented. The results are confronted with two group calculations, and systematic deviations are discussed. For the far subcritical cases a considerable deviation of about 5% of the theoretical reactivity values remains unexplained. 16 references. (auth)

14254 (EURFNR-1051) INTERCOMPARISON OF DIFFERENTIAL NEUTRON SPECTROMETRY TECHNIQUES IN THE MOL-ΣΣ FAST ASSEMBLY. Bluhm, H.; Fieg, G.; Werle, H.; Ames, H.; Braak, J. P.; Harry, R. J. S.; Montizaan, J.; De Leeuw-Gierts, G.; De Leeuw, S. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Jul 1972. 37p. (KFK-1658; RCN-172; BLG-471). Dep. NTIS (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

The determination of neutron spectra by means of differential spectrometry techniques is a powerful tool to check and evaluate nuclear data. But to reach this objective it is of primary importance to define the confidence that may be attributed to the spectral results wearing errors and uncertainties related to many parameters, such as cross-sections of the reaction used, detection equipment and unfolding codes. Though only an intercomparison on a large scale can give a valuable estimation of the uncertainties, the differential neutron spectrometry techniques of KFK, RCN and C.E.N./S.C.K., i.e. (n,p), ^{3}He(n,p)t and ^{6}Li(n,α)t were intercompared in the MOL ΣΣ fast assembly. An agreement of ±5% is generally found between 0.02 and 4 MeV. 27 references. (auth)

14255 (FEI-273) INVESTIGATION OF THE DISTRIBUTION OF CAVITIES OVER THE PERIMETER OF X18H9T STEEL FUEL ELEMENT CANS OF THE BR-5 REACTOR. Rentov, V. F.; Farkhutdinov, K. G.; Ladygin, A. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1972. 10p. Dep. NTIS (U. S. Sales Only).

The results are presented of electron-microscope studies of the development of porosity in varying areas of the perimeter of cans made of X18H9T steel, in which a peripheral temperature inequality exists. Shown is the presence of irregular expansion over the can perimeter of the fuel element which may lead to bending or destruction of the fuel element. (auth)

14256 (FMRB-43/72) ANALYSIS OF THE NEUTRON SPACE IN A REACTOR WITH TWO WEAKLY COUPLED CORES. Viehl, Eckart (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Sep 1972. 77p. (In German). Dep. NTIS (U. S. Sales Only).

Starting from the reactor kinetic equations, analytical expressions of the auto and cross spectral densities for the fluctuating currents of the output signals from two ion chambers are obtained, including the case of extremely asymmetrical power distribution in the two cores. By means of this theory, the properties of the "Forschungs- und MeBreaktor Braunschweig" (FMRB) are extracted from measurements: the reactivity of the isolated cores, the coupling reactivity, and the reactor power. The measured values are in good agreement with the results obtained by other methods. The measuring time, however, is essentially shorter than in conventional methods, whereas the uncertainties are comparable. (25 references) (auth)

14257 (GU-5285) PROOF TEST FACILITY: EXPERIMENTS AND ANALYSIS. Dresden Plutonium Demonstration Program. Doshi, P. K.; Brooks, W. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Oct 1972. Contract AT(11-1)-2210. 46p. Dep. NTIS.

The PTF is a light water moderated, zero power critical facility which has been specially constructed to perform experiments on production fuel assemblies. Under the Dresden Demonstration Program, the experiments were performed on Cycle 7 mixed-oxide and uranium BWR assemblies designed and manufactured by Gulf United. The primary purpose of the PTF experiments was a final quality assurance verification of the uniformity of the reactivity of the manufactured assemblies. In addition, experiments were performed to determine burnable poison rod gadolinium worth and moderator temperature coefficients in the mixed-oxide lattices as well as critical loadings for various configurations containing mixed-oxide assemblies. The results are summarized. 16 references. (auth)

14258 (GULF-RT-B-12154) TIME-OF-FLIGHT SPECTRUM MEASUREMENTS IN THE ^{235}U-FUELED FAST SUBCRITICAL REACTORS, STSF-7, -9, AND -10. Neill, J. M.; Young, J. C. (Gulf Radiation Technology, San Diego, Calif.). 17 Oct 1972. Contract AT(04-3)-167. 146p. Dep. NTIS.

Spectral measurements were made by time of flight in three different fast reactor assemblies; details of these assemblies and the measured results are documented. Dieaway measurements were made utilizing the time of flight detector itself and were sensitive enough to measure differences resulting from cell heterogeneity changes only. The spectrum measurements were also able to observe and track the heterogeneities of each reactor. The agreement of measurement and calculation with respect to plate heterogeneities over the significantly populated energy range was sufficiently good that remaining uncertainties in the treatment of heterogeneities should be small compared to those from nuclear data inadequacies. 21 references. (auth)

14259 (HEDL-TME-71-124) OVERALL OUTLINE OF RESPONSIBILITY FOR CONSTRUCTION OF THE FAST FLUX TEST FACILITY. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. Contract AT(45-1)-2170. 10p. Dep. NTIS.

The working arrangements are described under which the Hanford Engineering Development Laboratory (HEDL), Westinghouse Advanced Reactors Division (RPD), the Bechtel Cor-

poration, and the U. S. Atomic Energy Commission (AEC) will work together in carrying out their respective responsibilities during the construction, testing, and early operation of the Fast Flux Test Facility (FFTF). (auth)

14260 (HEDL-TME-72-111) IVHM PROTOTYPE GRAPPLE TESTS WITH SIMULATED CORE MOCKUP (SCM). Kocher, L. F. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1972. Contract AT(45-1)-2170. 48p. Dep. NTIS.

Functional performance tests conducted at HEDL on the prototype grapple for the FFTF In-Vessel Handling machine indicated that grapple performance was satisfactory except for problems with grapple bearings and alignment. The prototype grapple was returned to the vendor (Atomics International) for further work. 3 references. (auth)

14261 (HEDL-TME-72-119) FTR DRIVER PISTON RING WATER LEAKAGE RATES. Collingham, R. E.; Hill, V. R. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1972. Contract AT(45-1)-2170. 61p. Dep. NTIS.

The results of water leakage tests are reported for the 17-4 PH piston rings being considered for the FTR fuel assembly nozzles. The liner material was age-hardened Inconel 718. Without cycling, the leakage rates were within anticipated values (<250 lbm/hr). However, less than 10 thermal ratcheting simulation cycles caused galling and a corresponding ten-fold increase in leakage rates. The maximum leakage rate was about 1% of average fuel assembly flow. Additional piston ring design and testing is recommended to eliminate galling. 5 references. (auth)

14262 (HEDL-TME-72-135) MULTIGROUP REACTION CROSS SECTIONS FOR FTR APPLICATION. Kidman, R. B. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1972. Contract AT(45-1)-2170. 41p. Dep. NTIS.

A preliminary 42-group reaction cross section set consisting of 100 different reactions was generated for FTR application. These reactions are for use with flux distributions generated by diffusion or transport calculations employing the FTR 300-S cross section set. 14 references. (auth)

14263 (INR-659) HELENA CODES FOR MATERIAL BUCKLING DETERMINATION IN SUBCRITICAL ASSEMBLIES. Dabrowski, Cyryl; Mikulski, A. T. (Institute of Nuclear Research, Warsaw (Poland)). Oct 1965. 94p. Dep. NTIS (U. S. Sales Only).

Codes for computation of material buckling from thermal neutron flux distributions in an unreflected subcritical assembly, written in GIER ALGOL III language, are described. Three methods are elaborated: based on vertical axis measurement of neutron flux and an assumption of thermal neutron point source, based on horizontal plane and vertical axis measurement of neutron flux, and based on two horizontal planes measurement of neutron flux. A code for the determination of the extrapolation length is given. 12 references. (auth)

14264 (INR-P-977) INVESTIGATION OF THE PHYSICAL PARAMETERS OF THE WWR-SM LATTICES. Adamski, L.; Bouzyk, J.; Jozefowicz, E. T.; Jozefowicz, K.; Kowalska, K.; Kubowski, J.; Latek, S. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 50p. Dep. NTIS (U. S. Sales Only).

The investigated WWR-SM cores, examined on the critical assembly MARYLA-2, are described in brief. Three groups of experiments and calculations were carried out: (A) critical experiments and calculations for the determination of the critical mass or critical water level, macroscopic neutron distribution and material buckling; (B) intracell measurements and calculations for the determination of the microscopic neutron distribution, resonance parameters and spectral indices; and (C) kinetic measurements and critical calculations for the determination of the differential reactivity change with water level, built in reactivity and effectiveness of control rods. 10 references. (auth)

14265 (INR-P-989) CLADDING TEMPERATURE MEASUREMENTS OF THE WWR-SM TYPE FUEL ELEMENTS IN EWA-10 CORE. Czerniewski, M.; Labno, L. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 34p. Dep. NTIS (U. S. Sales Only).

As a part of EWA-10 reactor start-up measurements program after its reconstruction connected with power level increase, measurements of cladding temperature of a new type of fuel element were carried out. The main purpose of the measurements was to collect the necessary data for hazard report elaboration and to estimate the core cooling conditions for nominal values of the power level. A WWR-SM-type fuel element was equipped with 8 thermocouples installed in the fuel cladding and 2 thermocouples measuring the inlet and outlet water temperature. Measurements for steady and transient states were performed at forced and natural convection flow. The dependence between the maximum power level and values of flow rate and cooling water temperature for assumed temperatures of fuel cladding has been determined. (auth)

14266 (LA-tr-72-29) IBR-2 PULSED REACTOR AS A SOURCE OF NEUTRONS. Yazvitskii, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from a Russian report. 22p. Dep. NTIS.

Design parameters for the IBR-2 Reactor are presented. Physics measurements for the reactor are also included. (DCC)

14267 (RT/ING-(72)10) PROBLEMS CONNECTED WITH SODIUM FUEL INTERACTION IN THE PEC REACTOR SAFETY EVALUATION. De Cecco, L.; Santandrea, E. (Comitato Nazionale Energia Nucleare, Rome (Italy). Divisione Affari Internazionali e Studi Economici). 23 Jun 1972. 27p. (RVT-PEC-610). Dep. NTIS (U. S. Sales Only).

Problems connected with liquid sodium and fuel interaction in the PEC reactor are described. Formal requirements for the final design of the fuel and control system are presented. Preliminary results of theoretical studies evaluating the conversion of thermal energy into mechanical energy in a fuel-coolant thermal reactor are included. 11 references. (auth)

14268 (SC-RR-720861) REFLECTOR BURST EXPERIMENT WITH SPR-II. Schmidt, T. R.; Reuscher, J. A. (Sandia Labs., Albuquerque, N. Mex.). Nov 1972. 27p. Dep. NTIS.

The results of an experiment conducted with the SPR-II reactor are described in which a non-fissile external reflector element was used to rapidly add sufficient reactivity for a super prompt critical power excursion. A linear drive assembly was used to raise an aluminum reflector from below the core tangential to the side. Bursts with yields up to 298°C ΔT were made with no deviations in normal operational procedures or results. The experiment successfully demonstrates the feasibility of using reflector elements for control of fast burst reactors. 6 references. (auth)

14269 (SRARI-P-139) EFFECT OF PARTIAL OVERLOADS ON THE CHARACTERISTICS OF HIGH-FLUX REACTORS OF THE TRAP TYPE. Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The partial overload of the fuel in the research reactor core can be used either for burnup increase in the discharged fuel assemblies at a given core volume and thermal capacity of the reactor or for decrease of the core volume and thermal capacity of the reactor without any losses in burnup. Both these factors are considered as well as the analysis of the partial overload effect on the other reactor characteristics; reactor utilization factor, the necessary effectiveness of the control and safety members, and an optimum burnup. The expediency of the fuel partial overload in the high-flux trap-type reactors is examined. (auth)

14270 (ZJE-125) SR-OA REACTOR FIRST CRITICAL EXPERIMENT. Dach, K.; Fleischhans, J.; Hrdlicka, Z.; Kott, J.; Nemec, J.; Boucek, F. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1972. 17p. Dep. NTIS (U. S. Sales Only).

A brief technical description of the zero power research reactor SR-OA is presented. The main principles and aims of the critical experiment, experimental equipment, methods of evaluation and fundamental results are summarized. (auth)

14271 MEASUREMENT OF FISSION RATIOS IN ZERO POWER REACTORS. Pazirandeh, A. (Univ., Teheran); Besant, C. B. J. Brit. Nucl. Energy Soc.; 11: No. 4, 377-82 (Oct 1972).

Fission rate ratios of ^{238}U relative to ^{235}U were measured in the reactor CONSORT by detecting the fission product gamma activity from irradiated uranium foils. It was necessary to utilize a time-dependent calibration factor to relate the gamma activity ratio to the true fission ratio. Possible systematic errors in the technique were investigated in detail. The technique was used by other laboratories for measurements in fast reactors and so the neutron spectrum dependence of parameters, such as the time-dependent calibration factor, was examined. It was found that the calibration factor can change by 6% in going from a typical thermal reactor spectrum to a typical fast reactor spectrum. The overall systematic error in fission rate measurements was reduced to 1.5%. Comparisons between experimental $^{238}U/^{235}U$ fission ratios and predictions using the GMS-I code were also made. (auth)

14272 MEASUREMENTS OF NEUTRON FLUX DENSITIES AT THE RESEARCH REACTOR TRIGA HEIDELBERG. Hoever, K.-H.; Lorenz, W. J.; Ostertag, H.; Juenger, D. (Deutsches

Krebsforschungszentrum, Heidelberg). Kerntechnik; 14: No. 7, 311-15(Jul 1972). (In German and English).

Experiments are reported in which the thermal neutron flux density at three irradiation locations was measured by activation of gold foil probes. The epithermal neutron flux density was determined by means of resonance probes; the 1/E distribution law of the epithermal neutron flux density was confirmed using probes with resonance energies between 1.45 and 3.37 eV. The fast-neutron flux density was determined in 1-MeV energy intervals by means of 14 energy reactions up to an energy above 13 MeV. (auth)

14273 OSCILLATION MEASUREMENTS IN CRITICAL ASSEMBLIES. Brunet, M. (CEN, Cadarache, France); Darrouzet, M. Bull. Inform. Sci. Tech. (Paris); No. 170, 41-50(May 1972). (In French).

The oscillation technique is particularly useful for neutron measurements involving small quantities of material (a single fuel element or small sample). The methods used and the equipment employed are described. Results obtained with thermal and fast reactors are analyzed. (France)

14274 NUCLEAR PROPERTIES AND FUTURE PLAN OF HIGH-FLUX REACTOR. Shibata, S. (Kyoto Univ.). Genshiryoku Kogyo; 18: No. 2, 16-24(Feb 1972). (In Japanese).

Present status of KUR (Kyoto University Reactor, 5 MW) is discussed with particular emphasis on the increasing number of experiments being performed on it. Special experimental facilities are also described together with plans for further improvement. Present status and properties of high-flux reactors in foreign countries are also reviewed. Finally, design of the high-flux reactor to be built in Japan is discussed. Main features of the design are: (1) A light-water moderated 30-MW reactor with highly enriched uranium. (2) The core is divided into two parts by slab moderators from which a high-flux beam can be obtained. (3) Three-dimensional arrangement of beam holes. (4) Peak value of thermal flux is about 7×10^{14} n/cm^2/sec. (Japan)

14275 METHODS OF INTERPRETING NEUTRONIC EXPERIMENTS. Laponche, B. (CEN de Saclay, Gif-sur-Yvette, France); Barre, Y. Bull. Inform. Sci. Tech. (Paris); No. 170, 87-94(May 1972). (In French).

Experimental reactor physics seldom yields results which can be used directly by reactor designers. Such results require analysis. Recently made improvements are described together with the analytical methods applied to critical, exponential, perturbation, substitution, and oscillation experiments. (France)

14276 SUBSTITUTION EXPERIMENTS. Caumette, P. (CEN, Cadarache, France). Bull. Inform. Sci. Tech. (Paris); No. 170, 37-40(May 1972). (In French).

In substitution experiments, the reference lattice of a reactor is successively (from the center outwards) replaced by the lattice under investigation. Information is obtained about the fundamental properties of the medium studied such as material buckling. Experiments carried out with Cesar, Marius, and Masurca are briefly described. (France)

14277 COMPARISON OF HIGH-FLUX RESEARCH REACTORS. Tsykanov, V. A. At. Energ. (USSR); 33: No. 4, 849-50(Oct 1972). (In Russian).

General methods for making comparisons of high-flux reactors are propounded. No single criterion will suffice for such a comparison, since at least two questions must always be answered concerning the rate of obtaining information on irradiated samples versus the economics of the process. Optimum burnup calculations are illustrated for a typical high-flux reactor. (K.S.W.)

14278 EXPERIMENTS AND CONSIDERATIONS FOR THE DESIGN AND THE POWER INCREASE OF THE FRG-2. Krull, W. Kiel; Kiel Univ. (1971). 91p. (In German).

Thesis.

In material testing reactors a very high fast neutron flux density in a large number of irradiation positions is desired. To reach this for the FRG-2, many measurements have been made to determine the nuclear design (microstructure distribution of the thermal neutron flux density, dependence of the form factor on shim rods, capsules, position of capsules, reflector, and complex core-configuration). Combined with a new thermodynamic design and design considerations an increase of the reactor power and of the fast neutron flux density of 50% is possible. It can be shown, that for a further development of the FRG-2 (^{235}U content of the fuel elements, total number, and design of the shim rods, control rod program, compact core configuration, reflector, condition for the power scram) the fast neutron flux density can be increased by a factor 1.65. The fast neutron flux density in the irradiation positions of the FRG-2 is then a maximum from 2.5 to 3.0×10^{-2} s^{-1} for a reactor power of from 22 to 25 MW, which depends on the reactor lattice and the yearly variation of coolant conditions. (GF)

14279 REACTOR CONSTRUCTION: OPERATION AND UTILIZATION OF THE FR 2 IN 1971. Nucleus (Bonn); 18: No. 11, 95-6(1972). (In German).

The most important operating results of the eleventh year of operation are given. (GF)

14280 REACTOR CONSTRUCTION: GERMAN–FRENCH RESEARCH REACTOR OPERATING AT FULL POWER. Nucleus (Bonn); 18: No. 1-2, 4-5(1972). (In German).

French-German cooperation in the joint project is briefly reported. (GF)

14281 FACILITY FOR NEUTRON SCATTERING EXPERIMENTS. Alston, W. C. H.; Jones, T. C. (London Univ.). J. Phys., E (London); 6: No. 1, 51-4(Jan 1973).

A flexible, multi-level facility for experiments in neutron scattering by single crystals, inelastic neutron scattering, neutron time-of-flight, and neutron radiography is described. Details of the design for the in-pile collimators and beam shutters are provided. Results of measured gamma dose rates are presented and possible improvements to the shielding are discussed. (auth)

14282 PRODUCTION OF TRANSURANIUM ELEMENTS IN SM-2 AND MIR REACTORS. Davidenko, V. A.; Zamyatnin, Yu. S.; Tsykanov, V. V.; (and others). At. Energ. (USSR); 33: No. 4, 815-19(Oct 1972). (In Russian).

Experimental results on the accumulation of various isotopes of transuranium elements are reported. For the irradiation of plutonium, a loop-type MIR reactor has been adapted to produce ^{242}Pu, ^{243}Am, and ^{244}Cm without detriment to the basic program. The accumulation of even isotopes of curium and transcurium elements took place in the neutron trap of a multi-purpose high-flux SM-2 reactor. Experimental samples of elements having an elevated content of even-odd and odd–odd isotopes were produced by irradiation of the initial materials in the hard spectrum inside the fuel assemblies of this reactor. Effective neutron cross-sections have been determined for isotopes involved in successive transformation chains. For a number of particular starting materials, the calculation of isotope accumulation under actual irradiation conditions has been performed. These data are compared with experimental accumulation curves. Used targets, their conditions of operation in the reactors and methods of containment control during irradiation are briefly described. (auth)

14283 FUEL IRRADIATION AND FISSION GAS ANALYSIS FACILITY AT THE REACTOR BR2. Stechemesser, H. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 14: No. 10, 484-8 (Oct 1972). (In German and English).

A facility for the irradiation of coated particles and fission gas analysis built at the Belgium Reactor-2 for irradiation studies related to the THTR program is described. The complete facility consists of two identically designed irradiation systems, each consisting of a three-capsule rig with a control device for the irradiation temperature and three separate helium sweep circuits with their operational instrumentation. The individual irradiation capsules are connected via the sweep circuits to a fission gas analysis station controlled by a process computer. (auth)

14284 APPLICATION OF THE MODULAR DESIGN PRINCIPLE TO THE DEVELOPMENT OF EXPERIMENTAL FACILITIES. Schmidt, F. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 14: No. 10, 478-83(Oct 1972). (In German and English).

The feasibility of applying the modular design principle to experimental facilities for research and development work is discussed, and the advantages of applying this principle are illustrated by considering the development of reactor rigs for fuel and structural materials irradiation experiments. (LCL)

Production Reactors

14285 (DUN-7794) DOCUMENTATION OF THE EXAMINATION OF INCONEL 600 TUBING FROM STEAM GENERATOR 6B. Schmidt, J. P.; Kratzer, W. K. (Douglas United Nuclear, Inc., Richland, Wash.). 4 Nov 1971. 4p. Dep. NTIS.

Steam generator tubing is subjected to the severe service environment of primary liquid coolant and secondary steam and condensate. A routine surveillance program is conducted to detect unanticipated performance factors capable of endangering Inconel 600 tube life and to serve as the basis for remedial action in any such circumstance. (auth)

14286 (DUN-7905) STATUS OF THE 117-N CHARCOAL FILTERS, MARCH 1972. Bennett, E. C.; Strege, D. E. (Douglas United Nuclear, Inc., Richland, Wash.). 14 Mar 1972. 15p. Dep. NTIS.

Equipment Maintenance Standard N-603 specifies the periodic testing and examinations required on the N Reactor Confinement system to insure that the system can prevent the release of the radioactive materials generated in a reactor accident. The confinement system includes the 117-N Building, which contains filters to remove entrained matter in the building air before it is exhausted to the atmosphere through the exhaust stack. Each of these filters consists of three beds; the first removes entrained moisture, the second removes particulate matter, and the third, a charcoal filter, adsorbs halogens from the air. The results of the EMS testing performed on the charcoal filter beds currently installed in 117-N are summarized. 6 references. (auth)

14287 (DUN-7985) EVALUATION OF WEATHERED IMPREGNATED CHARCOALS FOR RETENTION OF IODINE AND METHYL IODIDE. Bennett, E. C.; Strege, D. E. (Douglas United Nuclear, Inc., Richland, Wash.). 30 Jun 1972. 21p. Dep. NTIS.

Extensive research and development studies have been under way on the factors that affect the ability of charcoal to adsorb iodine in its various forms. Fresh activated charcoal is very efficient for adsorbing elemental iodine (I_2), but pollutants from the transient air can degrade this capability, and organic iodide compounds tend to pass through charcoal at varying rates, the rate depending on a number of factors. A test program at N Reactor to determine the effect of weathering and aging on the efficiency of certain impregnated charcoals in adsorbing and retaining methyl iodide under conditions approximating those expected in a reactor accident is described. The results obtained from the N Reactor adsorber cells after six months exposure to reactor operating conditions are presented. 12 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 11862, 11931, 12092, 12098, 12325, 12391, and 12396.

14288 (AEC-tr-7341) STATUS REPORT UPON RESEARCH ON NUCLEAR REACTOR PRESSURE VESSELS COMMISSIONED BY THE FEDERAL MINISTRY FOR EDUCATION AND SCIENCE AT BONN. (Stuttgart Univ. (West Germany)). Translation of a German report. 78p. Dep. NTIS.

The performance of pressure vessel materials is analyzed for static and variable stress conditions. The effects of heat treatments and welds on material strength are investigated. The fracture characteristics of flawless and flowed, seamless and welded thick walled structural parts are studied. 116 references. (DCC)

14289 (ANL-Trans-919) MODIFICATION OF THE OXIDATION POTENTIAL OF THE MIXED OXIDES $(U,Pu)O_2$ AS A FUNCTION OF THE BURNUP. Schmitz, F.; Marticorena, J.; Dean, G. Translated from a French paper. 15p. (CONF-720843-8). Dep. NTIS.

From Behaviour and chemical state of fission products in irradiated fuel meeting; Vienna, Austria (7 Aug 1972).

The influence of the presence of fission products on the oxidation potential of mixed oxides was demonstrated in simulated oxides directly by measuring the emf of solid-electrolyte cells and indirectly by the influence on the lattice parameter of the matrix. The results indicate that the oxygen potential of mixed oxides containing fission products is lower than that of pure oxides. Moreover, various stabilizing mechanisms of this potential seem to be active, particularly the system Mo/MoO_2. 8 references. (auth)

14290 (ANL-Trans-920) VARIATION OF THE CARBON ACTIVITY AS A FUNCTION OF THE BURNUP IN A CARBIDE FUEL. Lorenzelli, Nicole; Marcon, J.-P. Translation of a French paper. 16p. (CONF-720843-5). Dep. NTIS.

From Behaviour and chemical state of fission products in irradiated fuel meeting; Vienna, Austria (7 Aug 1972).

Two important conclusions were drawn from the calculations: (1) The fission of a carbide-type fuel (UC or (U,Pu)C) consumes carbon as long as a higher carbide is present (M_2C_3). (2) The dissolution of soluble fission products (Zr, Nb, Mo, La, Ce, Nd, Y) in the UC matrix does not significantly modify its thermodynamic stability (activity of carbon and free energy of formation). 10 references. (auth)

14291 (ANL-Trans-929) FISSION GAS EMISSION BY URANIUM OXIDE IN FUEL ELEMENTS. Chenebault, Pierre; Delmas, Roger (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7–11 August 1972. 12p. (CONF-720843-1). Dep. NTIS.

In order to evaluate the quantity of fission gases emitted by uranium oxide under the conditions in which this fuel is used in "light water" and "heavy water–gas" reactor systems, two groups of methods were employed: analysis of the instantaneously emitted gases during irradiation and analysis of local concentrations in irradiated fuels. A study of the results obtained by these two techniques shows a correlation between the quantities of emitted gas and the principal irradiation parameters, i.e., temperatures, geometry and times. 12 references. (auth)

14292 (BNWL-tr-78) INVESTIGATION OF THE ESCAPE OF FISSION FRAGMENTS FROM CERAMIC NUCLEAR FUEL. Samsonov, B. V.; Frey, A. K. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from Russian Preprint. 19p. Dep. NTIS.

It is demonstrated that diffusion coefficients of gaseous fission products in the radiation process of ceramic fuel due to the intensive flux of thermal neutrons in the SM-2 Reactor decrease from an order of 4 – 6 (for ^{133}Xe) to an order of 2 – 4 (for ^{135}Xe) and 5 – 20 (for ^{138}Xe) if the results are interpreted according to the model of equivalent spheres. (auth)

14293 (EURFNR-1049) IRRADIATION OF VIBRATED PLUTONIUM RODS IN DIORIT. Schumacher, H.; Aerts, L.; Bairiot, H.; Bischoff, K.; Peter, J.; Rupar, H. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Aug 1972. 56p. (BLG-469; BN-7208-1; EIR-213). Dep. NTIS (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

Four vibrated fuel rods, 1% Pu-enriched, have been irradiated in the DIORIT research reactor at Wurenlingen, Switzerland. The fuel achieved maximum burnups between 3,000 and 10,000 MWd/t. U + Pu. Postirradiation examinations have been performed in the hot cells at Wurenlingen. Two fuel fabrication techniques for the preparation of the fine fraction have been selected (only this fraction contained plutonium): blended fuel, i.e. mechanically mixed PuO_2- and UO_2-fine powder fraction; and solid solution fuel, i.e. co-precipitated $(Pu_{0.067}, U_{0.933})O_2$ fine powder fraction. The postirradiation examinations gave the following results: all four vibrated fuel rods behave quite satisfactorily; at 790 W/cm maximum heat rating the center temperature reached about 2,000°C; the blended fuel showed a somewhat higher fission gas release than the solid solution fuel; and the solid solution fuel developed a central hole, possibly resulting from the alumina content. (5 references) (auth)

14294 (HEDL-TME-72-118) CABNED: A COMPUTER CODE TO CALCULATE ABSORBER BURNUP. Russcher, G. E.; Graves, N. J. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1972. Contract AT(45-1)-2170. 60p. Dep. NTIS.

CABNED is a code designed to calculate neutron absorption reactions in cylindrical geometry with three independent variables — neutron energy, exposure time, and position in the absorber, in different environments. Assumptions, both used and implied by the code, are described and discussed. Similarly, relationships that the code is based upon are described. The FORTRAN equations used are presented in appendices. (auth)

14295 (HEDL-TME-72-128) USER'S GUIDE FOR GAPCON: A COMPUTER PROGRAM TO PREDICT FUEL-TO-CLADDING HEAT TRANSFER COEFFICIENTS IN OXIDE FUEL PINS. Horn, G. R.; Panisko, F. E. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1972. Contract AT(45-1)-2170. 75p. Dep. NTIS.

GAPCON calculates gap conductances, temperature profiles, and other thermal and mechanical conditions in a fuel pin for any combination of fuel pin operating and design parameters. The program takes into account initial fuel and cladding dimensions, fill gas composition (including changes due to fission gas and sorbed gas release), fuel restructuring kinetics, and fission product induced swelling, and the variations of these parameters with time in reactor (burnup) and heat rating. Input to the program includes descriptions of the fuel pin, its environment, and operating conditions. 25 references. (auth)

14296 (RDT-STATUS-11-72) RDT STANDARDS SUMMARY. Bimonthly Status Report for the Period Ending November 30, 1972. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 12 Dec 1972. 40p. RSO.

A status report of RDT Standards for the period ending November 30,1972, which includes RDT standards for Responsible Standards Offices at HEDL, LMEC, and ORNL is presented. (auth)

14297 (SRARI-P-130) METHODS FOR INVESTIGATIONS OF EFFECTS OF REACTOR IRRADIATION ON THE ACCURACY OF THERMOCOUPLE READING. Markina, N. V.; Samsonov, B. V.; Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is known that thermocouples slightly change their readings when in radiation fields. The deviation in thermocouple readings due to radiation is analyzed. (auth)

14298 (SRARI-P-135) INVESTIGATION OF THE ESCAPE OF FISSION FRAGMENTS FROM CERAMIC NUCLEAR FUEL. Samsonov, B. V.; Frei, A. K. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 22p. Dep. NTIS (U. S. Sales Only).

It is demonstrated that diffusion coefficients of gaseous fission fragments in the radiation process of ceramic fuel due to the intensive flux of thermal neutrons in the SM-2 Reactor decrease from an order of 4-6 (for ^{133}Xe) to an order of 2-4 (for ^{135}Xe) and 5-20 (for ^{138}Xe) if the results are interpreted according to the model of equivalent spheres. (8 references) (auth)

14299 (UJV-2879-M) TRANSFER PHENOMENA IN OXIDE SYSTEMS OF NUCLEAR FUELS. Klima, Jaroslav (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1971. 44p. (In Czech). Dep. NTIS (U. S. Sales Only).

Theories of migration mechanisms in the oxide systems of nuclear fuels are reviewed. Their use in fast reactor analysis is emphasized and supported by available experimental data. 93 references. (auth)

14300 (WAPD-TM-1119) ^{235}U FISSION PRODUCT DECAY ENERGY 1972 RE-EVALUATION. Shure, K. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct 1972. Contract AT-11-1-Gen-14. 26p. Dep. NTIS.

Summation studies made with three programs of different degrees of sophistication using five different libraries containing different numbers of, as well as different physical parameters for, ^{235}U fission product nuclides indicate that the energy released is not sensitive to these differences for times $\geq 10^3$ sec after fission. For practical ^{235}U fueled reactors, it is shown that neutron absorption effects on fission product energy release are unimportant and the ^{235}U fission product energy release values in the proposed ANS standard on the subject are within a few percent of the values obtained from two recent programs and their updated libraries. 10 references. (auth)

14301 FUEL ELEMENT ASSEMBLIES FOR FLUID-COOLED NUCLEAR REACTORS. Williams, Michael Roger Lloyd; Stevens, Paul Alexander (to British Nuclear Design and Construction Ltd.). British Patent 1,283,195. 26 Jul 1972. Filed 17 Apr 1969.

The fuel element assembly described comprises a column of fuel elements slidably mounted on a tie bar, and a head unit located above the fuel elements and connected to the tie bar so that when the assembly is in position in a reactor fuel channel the head unit compressively loads the fuel elements vertically against a support located near the bottom of the fuel channel, thus releasing tension in the tie bar. The tie bar extends upwardly through a bore in the head unit, and the tie bar connection includes spring means arranged during lifting or lowering of the assembly to urge the upper end of the tie bar upwardly relative to the head unit. The upper portion of the head unit is adapted to slidably engage the lower portion of a plug for closing the reactor standpipe; this plug is arranged to release the tie bar from tension when the assembly is in position in the fuel channel, and to be detachably engaged by grab means for lifting or lowering the assembly through the standpipe. A sleeve member is slidably mounted on the tie bar, located between the plug and the head unit, so that when the assembly is in position in the fuel channel the plug forces the sleeve member downward and disengages the spring means from the tie bar. The head unit includes at least one neutron shield plug and at least one heat shield. The arrangement described overcomes difficulties in the event of an obstruction occurring in a fuel channel. (UK)

14302 NUCLEAR REACTOR FUEL ELEMENT CLUSTERS. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,283,530. 26 Jul 1972. Filed 20 Dec 1968.

In conventional clusters the fuel elements are spaced by grids one of which provides end location for the elements, and where the clusters are for use in a vertical attitude each fuel element sheath may have an end flange for supporting the element on a lower end locating spacer grid. The sheath is usually finned and flanged by machining and to reduce fabrication costs the flange has only the same radial depth as the finning. This leads to a conflict between the requirement for ease of insertion of the elements in the cells of the grid and reliability of end location. In the arrangement described the cluster comprises an array of spaced parallel fuel elements of circular cross section and a spacer grid having cells of diameter greater than that of the fuel elements. Each fuel element has a series of circumferential extended surfaces of equal radial depth and a loose collar interposed between an end extended surface and the rim of a cell, whereby the fuel element can be supported in a vertical attitude by the rim. Because the cells can be made substantially larger than the fuel elements, manufacturing tolerances can be relaxed. The loose collars can be chamfered and the rims of the cells countersunk to centralize the fuel elements in the cells. Each element may have a circumferential rib for assisting centralization of the element within the cell. (UK)

14303 POSITIONER FOR FUEL ELEMENTS. Mueller, A. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,464,970. 2 Jul 1970. Filed 30 Sep 1964. (In German).

The positioners for fuel rods that are assembled as fuel elements constitute flow bodies with essentially annular cross sections. They are arranged between the fuel rods preferably in several planes, whereby at least some of those flow bodies that lie side by side in the fission zone plane, are interconnected. Flow bodies in two planes are coupled together through diagonal rods, whereby the coupling rods in each plane run parallel while they form an angle with those in the other plane. The positions, characterized by tube sections as flow bodies, possess a circular bulge in their center and the ends are leveled. (H.B.G.)

14304 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR SHUT-DOWN SYSTEMS. Walker, A. (to British Nuclear Design and Construction Ltd.). British Patent 1,291,618. 4 Oct 1972. Filed 12 Jun 1970.

Disadvantages of conventional shut-down systems are stated. In the system described means are provided for injecting neutron absorbing material in particle form into the core channels, the particles passing below the core before entering the channels. The particles preferably pass upwards through an injection duct within or alongside each channel and are then released at or near the top of the channel. A retrieval duct is preferably provided, communicating between the outside of the reactor and a point at or near the bottom of a channel. In order to assist movement of the particles a gas may be injected into the system. (UK)

14305 JOINED PLATE STRUCTURES. Greenhalgh, F. G.; Hewins, J. A. (to United Kingdom Atomic Energy Authority). British Patent 1,290,677. 27 Sep 1972. Filed 17 Jul 1969.

Reference is made to methods of producing joined plate structures and in particular to methods of joining tank sections to form complete tanks. In the method described the plates are joined at their edges by abutting beadings that extend outwardly beyond at least one face of the plates and are bridged by spaced grooved numbers. The beadings and grooved members have co-operating tapered surfaces, and clamping bolts are provided that penetrate the beadings, whereby the grooved members are clamped to the beading extensions and the beadings are urged into abutment. The beadings may be pre-formed and welded to the edges of the plates, or may be formed integral with the plates. Details are given of the application of the method to tank sections. (UK)

14306 OPTIMIZATION OF LOW-TEMPERATURE MODERATOR. Watanabe, Noboru (Tohoku Univ., Sendai); Kimura, Motohaur; Oyamada, Masayuki; Kubota, Takeo; Takahashi, Funinobu. Kakuriken Kenkyu Hokoku; 3: No. 2, 61-4(Dec 1970). (In Japanese).

Experiments on the pulsed neutron characteristics of polyethylene at the temperature of liquid hydrogen are reported. A 10 cm × 10 cm wide polyethylene moderator was covered with a cadmium sheet 0.5 mm thick, and in direct contact with the liquid nitrogen. To avoid effect of epithermal neutrons scattered from the liquid nitrogen, a B_4C shield of 10 mm thick was placed 3 to 4 mm from the cadmium surface. The moderator thickness was taken as a parameter. The pulse shape of neutrons is shown by the relation of time vs. relative neutron flux for energy levels of 80 MeV, 45 MeV, 20 MeV and 5 MeV, respectively. Moderator thicknesses of 4 cm and 3 cm and room temperature and liquid nitrogen temperature were taken as parameters in each case. Above 45 MeV, the effect of low temperature on the sharpness of pulses is clearly seen. The effect of heterogeneous poisons on the sharpness of pulses is outstanding for neutrons of low energy. It was found that the optimum moderator can be obtained by the use of low temperature and heterogeneous poisons. (Japan)

14307 NUCLEAR FUELS: NATURAL URANIUM HAS BEEN CHEAPER IN 1971 THAN IN 1970. Nucleus (Bonn); 18: No. 9-10, 79-80(1972). (In German).

Uranium prices and price trends on the world market in 1970 and 1971 are briefly discussed. (GF)

14308 VISCOUS DAMPING AND AMPLIFICATION BY REPETITIVE PULSING OF RAPIDLY HEATED CYLINDERS. Grossman, R. J. Ann Arbor, MI; Univ. of Michigan (1972). 137p. University Microfilms Order No. 72-29,067.

Thesis.

An understanding of the complete thermo-mechanical response of the fuel elements is particularly important for fast burst reactors, repetitively pulsed fast reactors, and fast power reactors. In these reactors, the reactivity may be increased at such a rate that the inertia of a fuel element keeps it from expanding as quickly as it is heated. Two major problems may result. First, since thermal expansion is an important negative feedback mechanism, there may be a safety problem with high heating rates; and second, inertial stress waves may cause the fuel element to vibrate. Each reactivity pulse can give rise to a number of high amplitude stress waves which, in some cases, may damage the fuel elements. In addition, there is a possibility in repetitively pulsed fast reactors of vibration amplitude amplification if the repetitive pulsing occurs at or near an integral multiple of the fuel element natural period of vibration. The viscous damping mechanism for energy dissipation from the heated fuel element was examined. The experimental apparatus was then modified to study the amplification of vibration displacements due to repetitive pulsing. The theoretical model used to study viscous damping consisted of a long, thin rod, immersed in a fluid, and subjected to an energy input with a Dirac Delta Function time dependence. The applicable equations include conservation of energy in the sample, the equations of motion for both the sample and the fluid, and the thermoelastic stress-strain relationship. The time dependent sample displacement due to rapid heating was obtained for both the zero displacement and zero stress end conditions, using Laplace Transforms with contour integration required for inversion. The time dependent displacement of a rapidly heated sample subjected to viscous damping was determined experimentally for the free end case. The rapid heating was accomplished electrically by discharging a capacitor through a low inductance circuit containing a thin wall, hollow, cylindrical, stainless steel test sample. The sample was immersed in glycerine and the displacements due to the rapid heating were measured using a laser interferometer. A direct measurement of the damping was obtained by observing the differentiated output of the interferometer. The experimental results were in good agreement with the theory and showed that the viscous fluid has only a small effect on the sample vibrations and cannot be relied upon to significantly reduce the number of high amplitude stress cycles. The experimental apparatus was then modified to study the vibration displacement amplification of a test sample subjected to repetitive pulsing. An externally triggered spark gap switch was used to provide pulsing periods as low as 150 μsec. The measured maximum amplification was approximately 60% of that predicted in a previous theoretical analysis of this problem, while the experimental amplification as a function of the pulsing period agreed well with the theory. The results demonstrate that relatively large displacements may be obtained with a rather small energy deposition per pulse. Repetitive internal heating could be used for high cycle fatigue studies and also as a form of the resonance technique for determining both the sample natural frequency as well as the material relaxation time. (Diss. Abstr. Int., B)

14309 POISON FOR NUCLEAR FUELS. Gilissen, R.; Flipot, A. J. (to Centre d'Etude de l'Energie Nucleaire). Belgian Patent 781,976. 12 Apr 1972. (In French).

A process for manufacture of a burnable poison for fuel pellets with a uranium oxide base is described. (tr-auth)

14310 INVESTIGATION OF THE DISTRIBUTION OF TEMPERATURE WITHIN THE RIBBED WALL OF A REACTOR-VESSEL OF A NEW TYPE. Sebok, Ferenc. Musz. Tud.; 45: No. 1-2, 141-52(1972). (In Hungarian).

The distribution of temperature in a multi-layer wall of a new type of reactor-vessel is associated with two new features compared with the usual problems. These are: active thermal sources inside the wall that may be described as a sum of exponential functions and the temperature-dependence of the coefficient of thermal conductivity of the concrete revealing itself through drying. By taking these special features into account, the calculation may be carried out in a closed form on the basis of the boundary conditions consistent with the actual environmental conditions, by the solution of the Fourier equation written down in the cylindrical system of coordinates. By making use of the derived relationship, computer calculations can be used to estimate the effect of each of the factors. (auth)

Reactor Physics and Core Engineering

Physics

14311 (AEEW-R-814) COMPARATIVE STUDY OF VARIOUS LIGHT WATER SCATTERING MODELS USED IN THERMAL REACTOR CALCULATIONS. Butland, A. T. D.; Chudley, C. T. (Atomic Energy Establishment, Winfrith (England)). Oct 1972. 43p. Dep. NTIS (U. S. Sales Only). UK 1.00 pound.

A comparison between experimental measurements and theoretical predictions of integral parameters in various light water moderated cores is presented. Six scattering models were used in calculations, namely an unadjusted and an adjusted free gas, the Nelkin, an effective width, an early Haywood model, and a modification of Haywood's model due to Gulf General Atomic. (auth)

14312 (IAE-2155) PROMPT-NEUTRON LIFETIME CALCULATION BY MONTE CARLO. Frank-Kamenetskii, A. D.; Yudkevich, M. S. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

In prompt-neutron lifetime calculations it is necessary to estimate the quantity $J = (\zeta, \phi\phi^+)$, where ϕ is the flux, ϕ^+ is the importance function, and ζ is a given function. The method for the Monte Carlo calculation of J is presented in which ϕ and ϕ^+ are computed from the same random walk process. The value of the importance function at point x of phase space may be obtained as a number of neutrons in an "equivalent" critical reactor at $t = \infty$ if one neutron was introduced at $t = 0$ at point x. The proposed method is based on such a definition of the importance function and on the so-called "method with constant number of fission points" which is usually used in Monte Carlo criticality calculations. To calculate the quantity J, the track length estimator is used just as in the case of the calculation of $J_1 = (\zeta, \phi)$ but with additional weights. The weight of each neutron is defined as a number of descendants which this neutron will have after n generations. Such an estimator for J is proved to be unbiased at $n, N \to \infty$ (N is a number of neutrons in one generation). The two-dimensional code MMK-16 was developed which calculates the prompt-neutron lifetime using different approximations (from $n = 1$ to $n = 11$) for the importance function. At $n = 1$ it calculates the mean time from birth of a neutron to its production of a second neutron (the mean production time). Some numerical results obtained with MMK-16 are presented. They are compared with experiments and for sphérical systems with results of S_n calculations. (17 references) (auth)

14313 (INR-534) SPACE-ENERGY THERMAL NEUTRON DISTRIBUTION IN THE REACTOR CELL. Arkuszewski, J.; Kulikowska, T. (Institute of Nuclear Research, Warsaw (Poland)). Jul 1964. 19p. Dep. NTIS (U. S. Sales Only).

The method of calculation of the energy and space dependent thermal neutron flux (or density) in the reactor cylindrical cell is described. The Laguerre polynomial expansion with Amouyal–Benoist-type boundary conditions is used. The results of calculations for a NORA reactor cell are given. 10 references. (auth)

14314 (INR-1420) ON SOME ADVANTAGEOUS OF THE REACTOR DYNAMICS MODEL WITH POWER FEEDBACK. Bouzhik, Ya.; Gadomski, A.; Topa, E. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

An approach to the model of the dynamics of a research reactor based upon the power feedback only is presented. The advantages of the approach are shown, and a comparison of the results with experimental data is given. The model developed and the numerical programs elaborated have been applied to evaluate the reactivity of the control rod in a reactor at various power levels. (auth)

14315 (KFK-1650) KINETICS EQUATIONS FOR FAST REACTORS. Zweifel, P. F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Systemtechnik und Reaktorphysik). Jul 1972. 18p. Dep. NTIS (U. S. Sales Only).

The analysis of reactor kinetics experiments is, for historical reasons, based on models more appropriate to thermal than to fast systems. It is proposed that kinetics experiments analyses be carried out using only the ordinary multigroup operators, and that no

effort be made to introduce parameters such as neutron lifetime, effective delayed neutron fraction, etc. The resulting analysis is simpler and less likely to produce confusion. Period measurements and pile oscillator experiments are discussed, with variational principles being suggested for the analysis. (auth)

14316 (ORNL-TM-3372) SPACE AND ENERGY DEPENDENCE OF REACTOR FLUCTUATION SPECTRA. **Penland, J. R.** (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 148p. Dep. NTIS.

Thesis.

The understanding of spatial and energy dependence of reactor kinetics, and hence reactor fluctuation spectra, is essential to the operation and safety of nuclear power plants. In order to expand the knowledge of these phenomena, a system composed of a reactor surrounded by an infinite reflector was studied both theoretically and experimentally. A four node model was developed utilizing the Langevin conjecture to describe the fluctuations in the outputs of fast neutron and thermal neutron detectors located in both a reactor core and its reflector. The Pool Critical Assembly at Oak Ridge National Laboratory was used to experimentally approximate the four node model. Proton recoil scintillation detectors were inserted to detect fast neutrons and ^{10}B chambers were employed for thermal neutron detection. Cross- and auto-power spectral densities were obtained and compared with the four node theory and with a two energy group, one space point theory. The four node theory explains the shape of the core-reflector thermal cross-power spectral density. Otherwise the model presents no significant improvements over previous theories. The experiment proved that it is possible to measure the thermal neutron lifetime, independent of the delayed neutron fraction, from the fast-thermal cross-power spectral density. 33 references. (auth)

14317 (RT/FI-(72)26) KINE-2: A KINETIC CODE IN TWO-DIMENSION. **Buffoni, G.; Conforto, G.; D'Amico, P.; Galati, A.; Mosiello, R.; Musco, A.; Norelli, F.** (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 11 Jul 1972. 17p. (In Italian). Dep. NTIS (U. S. Sales Only).

The KINE-2 program is a FORTRAN IV code able to perform few-group, two-dimensional reactor kinetics calculations based on the metastatic method. Subprompt-critical excursions of reactivity can be studied via the KINE-2 program. (auth)

14318 SUBTHERMAL PULSED NEUTRON MEASUREMENTS IN POLYCRYSTALLINE MEDIA. **Rzeszot, T.; Warda, E.** (Inst. of Nuclear Research, Warsaw). J. Nucl. Energy; 26: No. 8, 419-29(Aug 1972).

Using the curved chopper as a source of subthermal neutron pulses the behavior of the thermal neutron flux decay in beryllium and graphite was studied in small samples of both moderators. In all cases the exponential decay was observed. Considering the crystalline properties of the moderators the new dependence $\lambda = \lambda(B^2)$ is proposed. UpsilonΣ_{in} = 1300 s^{-1} for graphite and upsilonΣ_{in} = 3450 s^{-1} for beryllium were obtained from the experiment. (auth)

14319 HYDRODYNAMICS OF FISSIONABLE MATERIALS. I. ACOUSTIC VIBRATIONS AT CONSTANT NEUTRON FLUX. **Novikov, V. M.** This paper was summarized in At. Energ. (USSR); 30: No. 5, 446(May 1971) as paper No. 487/5944. (In Russian).

Full copy of this paper is held by TIC.

A theory of gas-fueled reactor criticality has been developed in which oscillations in the density of the fuel are excited in the reactor. The reciprocal effect of the neutron flux on the hydrodynamics of the fissionable gas can be neglected, according to the underlying assumptions. This assumption would be valid when the amplitude of the neutron flux is not too large. The possibility of utilizing gas-fueled reactors for MHD generators is being discussed. In pulsed MHD generators of this type, the neutron flux would have to reach levels of $\sim 10^{17}$ neutrons/$cm^2 \cdot$ sec. In such a case the effect of the neutron flux on the hydrodynamics of the fissionable gas could no longer be ignored safely. It is demonstrated that the extent of this effect can be assessed from the value of the dimensionless ratio $\alpha = \beta(qNH/c_pc)$, where H is the reactor dimension; N is the neutron flux; β, c_p, c are respectively the volume expansion coefficient, specific heat, and the speed of sound traversing the fissionable material. (auth)

Core Thermal Hydraulics

14320 (FEI-249) USE OF A MODEL OF A POROUS BODY FOR CALCULATING THE FIELD, VELOCITY, AND TEMPERATURE OF A REACTOR CORE. **Kolmakov, A. P.; Yur'ev, Yu. S.** (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A system of differential equations in hydraulics and heat exchange is considered in the light of a reactor core as a "porous body" with anisotropic properties. The equations are solved in a linear approximation for the case of small deviations from canal geometry. (tr-auth)

14321 (UJV-2887-R) HEAT TRANSFER IN TURBULENT LONGITUDINAL FLOW THROUGH UNBAFFLED ASSEMBLIES OF FUEL RODS. **Pfann, J.** (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 33p. (In Czech). Dep. NTIS (U. S. Sales Only).

A numerical analysis of heat transfer in turbulent longitudinal flow through assemblies of unbaffled fuel rods is presented. The solution applies to infinite triangular or rectangular arrays of fuel rods with velocity and temperature profiles fully developed for fluids with Prandtl number Pr ~ 1 and Pr $\ll$ 1. In the case of liquid metals the thickness and heat conductivity of cladding and bond are considered but the turbulent heat transport is neglected with respect to the heat conduction. Some interesting results and the comparison of both cases with Pr ~ 1 and Pr $\ll$ 1 have been shown for the dimensionless rod spacing in the range of x = 1.0 – 1.6. Theoretical predictions and experimental data of various investigators dealing with the dependence of heat transfer on the dimensionless rod pitch were illustratively compared and relatively good agreement was found. 20 references. (auth)

14322 METHOD FOR THE COMPUTATION OF HEAT TRANSFER CONDITIONS IN CLOSELY PACKED GRIDS. **Schraewer, R.** Atomwirt., Atomtech.; 17: No. 11, 559-60(Nov 1972). (In German).

A method for computing the heat transfer in reactor cores is described. The fuel element grid is infinite; the velocity profile of the cooling medium is given and the heat source density is constant throughout the cross section of the pellet. This method permits calculation of the temperatures in the rods and in the cooling media, especially in liquid metals. (HBG)

GENERAL

Energy Economics

Refer also to abstract 11961.

Law

14323 (STI/PUB–333) EXPERIENCE AND TRENDS IN NUCLEAR LAW. Legal Series No. 8. A Selection of Papers Presented at the Seminar on the Development of Nuclear Law, Bangkok, 6–11 April 1970 and The Inter-Regional Training Course on the Legal Aspects of Nuclear Energy, Athens, 7–18 December 1970. (International Atomic Energy Agency, Vienna (Austria)). 1972. 169p. IAEA $6.00.

Selected papers from a seminar on the development of nuclear law are presented. The 16 papers are arranged in 5 sections that are each concerned with one of the following topics: nuclear safety and environmental protection; supply of nuclear materials; nuclear liability and insurance; conventions, agreements, and legislation on nuclear-powered ships; and nuclear legislation in Asia and the Far East. (E.R.B.)

Management

Refer also to abstract 14323.

14324 (BNWL-SA–4459) PROBLEMS FOR RADIATION PROTECTION SPECIALISTS IN SAFETY EVALUATIONS. Unruh, C. M. (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1972. 55p. (CONF-721122–1). Dep. NTIS.

From Regional study group meeting on radiological and environmental protection; Istanbul, Turkey (20 Nov 1972).

The basic duties of radiation protection personnel are reviewed. Additional training needed by those engaged in specialized fields is discussed. These fields include: radiation monitoring and surveillance; personnel dosimetry; radiation standards; radiological instrument design; nuclear safety; nuclear material management; environmental evaluations; and radiological emergencies. (CH)

14325 REPORT ON THE PHILIPPINE ATOMIC ENERGY PROGRAM. Ibe, L. D. (Philippine Atomic Energy Commission, Manila). Sci. Rev. (Manila); 12: No. 1, 7-18(1972).

A review is presented of the major phases of the Philippine atomic energy program. The following topics are discussed: acquisition and operation of a nuclear research reactor; establishment of a center for nuclear research and development; manpower development; promotion of the uses of radioisotopes and application of nuclear techniques; establishment and enforcement of radiological health and safety standards; feasibility study of nuclear power plant in Luzon; international cooperation; and future programs. (H.L.W.)

14326 TEN INNOVATIONS. An International Study on Technological Development and the Use of Qualified Scientists and Engineers in Ten Industries. Layton, C. London; George Allen and Unwin Ltd. (1972). vp. 3 Pounds 50 Pence.

Ten chapters on the use of qualified engineers and scientists in ten separate industries are presented. A separate abstract was prepared for one chapter on the nuclear industry. The remaining nine studies on industries deal with aircraft, vehicle engines, knitting machines, color television, float-glass process, semiconductors, ethylene production, automated machine tools, and oscilloscopes. (LCL)

For an abstract of an individual chapter see: 14059.

Mathematics and Computers

Refer also to abstract 12213.

14327 (LA–5118) MCA FOCAL: A REAL-TIME PROGRAMMING SYSTEM FOR MULTICHANNEL ANALYSIS ON A PDP-9/PDP-15 COMPUTER. East, L. V.; Aebersold, P. M. (Los Alamos Scientific Lab., N. Mex.). Dec 1972. Contract W-7405-eng-36. 17p. Dep. NTIS.

A programming system based on a modified FOCAL interpreter is described for a PDP-9/PDP-15 computer equipped with specific hardware. User programs written in FOCAL may be used to control the acquisition of multichannel pulse height data and perform data analysis. A switch panel and CRT display with a light pen are utilized to allow the user a high degree of interaction with the data acquisition routines. (2 figures, 6 tables) (auth)

14328 (LTH-IR–7228) ON THE CONVERGENCE PROPERTIES OF THE GENERALIZED LEAST SQUARES IDENTIFICATION METHOD. Soederstroem, T. (Lund Inst. of Tech. (Sweden). Div. of Automatic Control). Nov 1972. 146p. Dep. NTIS (U. S. Sales Only).

An analysis of the convergence properties of the generalized least squares method is presented. Two different variants are examined. They correspond to different ways of estimating the correlation of the residuals. It is shown that one of those variants is equivalent to a maximization of the likelihood function of the problem, when suitable assumptions are made. In this case the possible result of the method is closely related to the number of local minimum points of a corresponding loss function. Under the assumption of suitable regularity conditions of the input signal and the system dynamics, the following is theoretically shown in the report. For every given system the minimization gives the true values of the parameters if the signal to noise ratio is high enough. It is further shown that the minimization may give incorrect values of the parameters if the signal to noise ratio is low enough. In this case the loss function has no unique local minimum point. The second variant is the one proposed by Clarke. By counter examples it is shown that this variant may also give wrong estimates for high noise levels. The existence of wrong parameter estimates is illustrated by numerical examples. Plant measurements as well as simulated systems are used. Identification of dynamics of the OECD Halden Boiling Water Reactor is presented as an example of lack of uniqueness for industrial data. (20 references) (auth)

14329 COMPUTERS IN INDIA. A REVIEW. Ramani, S. (Tata Inst. of Fundamental Research, Bombay). At. Energy Rev.; 10, No. 3, 401-15(Sep 1972).

Scientific activity in India in the area of computer technology is reviewed. Research and development in the fields of hardware and software, planning and management of computer centres, and the application of computers in science and technology are some of the topics covered. Progress in education and training in the area is also discussed. Special attention is given to subjects relating to nuclear science and technology. The role of the Indian atomic energy program in creating and developing expertise in computer technology is described. (auth)

Miscellaneous

14330 (AAEC/TM–615) QNPRINT: AN ALTERNATIVE PRINTER FACILITY FOR THE IBM360 COMPUTER. Backstrom, R. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1972. 15p. Dep. NTIS (U. S. Sales Only).

14331 (AAEC/TM–622) CORRELATIONS AND CONVENTIONS FOR THE THERMODYNAMIC PROPERTIES OF AQUEOUS IONS. Lowson, R. T. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1972. 18p. Dep. NTIS (U. S. Sales Only).

14332 (ACRH–1000-390) PASSIVE ANTIBODY DELAYS DEVELOPMENT OF CELL MEDIATED IMMUNITY IN RATS RECEIVING RENAL ALLOGRAFTS. Biesecker, J. L.; Fitch, F. W.; Rowley, D. A.; Stuart, F. P. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill.). 1971. 9p. (CONF-720941–2). Dep. NTIS.

From 4th international transplantation society conference; San Francisco, CA (24 Sep 1972).

14333 (ACRH–1000-391) BASIC PRINCIPLES OF RADIOGRAPHIC TOMOGRAPHY, AND POTENTIAL APPLICATION TO NUCLEAR MEDICINE. Collins, P. A.; Gottschalk, Alexander (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Radiology). 1972. 11p. (CONF-720959–2). Dep. NTIS.

From Symposium on radionuclide tomography; New York, NY (15 Sep 1972).

14334 (ACRH–1000-393) ERYTHROPOIETIN AND THE INDUCTION OF ERYTHROID CYTODIFFERENTIATION. Goldwasser, E. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Biochemistry). 1972. 12p. (CONF-720633–2). Dep. NTIS.

From 4th international congress of endocrinology; Washington, D. C. (19 Jun 1972).

14335 (ACRH-1000-397) COMPARISON OF THE CARCINO-EMBRYONIC ANTIGEN (CEA) IMMUNOASSAY AND THE RADIOLOGIC COLON EXAMINATION IN THE DIAGNOSIS OF CARCINOMA OF THE COLON; PRELIMINARY RESULTS. McCartney, W. H.; Hoffer, P. B. (Chicago Univ., Ill. Dept. of Radiology. Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 15p. Dep. NTIS.

14336 (ACRH-1000-403) ^{67}Ga SCANNING IN THE STAGING OF MALIGNANT LYMPHOMA. Turner, D. A.; Gottschalk, A.; Hoffer, P. B.; Harper, P. V.; Moran, E.; Ultmann, J. E. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill.). 1972. 22p. (CONF-721017-4; SM-164/143). Dep. NTIS.
From Symposium on medical radioisotope scintigraphy; Monte Carlo (23 Oct 1972).

14337 (AEEW-M-1123) NEW MODEL FOR THE DYNAMICS OF STEAM DRUMS. Hopkinson, A. (Atomic Energy Establishment, Winfrith (England)). Mar 1972. 9p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

14338 (AEEW-M-1139) POSSIBLE MECHANISM FOR THE ATTENUATION OF THE EFFECT OF WALL FRICTION IN TWO-PHASE FLOW. Shires, G. L. (Atomic Energy Establishment, Winfrith (England)). Oct 1972. 8p. Dep. NTIS (U. S. Sales Only).

14339 (AEEW-R-806) FADDEEV: A FORTRAN CODE FOR THE CALCULATION OF THE FREQUENCY RESPONSE MATRIX OF MULTIPLE-INPUT, MULTIPLE-OUTPUT DYNAMIC SYSTEMS. Owens, D. H. (Atomic Energy Establishment, Winfrith (England)). Jun 1972. 31p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

14340 (AEEW-R-809) DIFFUSION CONTROLLED ELECTROCHEMICAL MASS TRANSFER MODELLING TECHNIQUE FOR HEAT TRANSFER STUDIES. Mackley, N. V. (Atomic Energy Establishment, Winfrith (England)). Oct 1972. 14p. Dep. NTIS (U. S. Sales Only).

14341 (AERE-BIb-181) LIQUID CRYSTALS FOR NON-DESTRUCTIVE TESTING. Wall, M. A. (Atomic Energy Research Establishment, Harwell (England)). Oct 1972. 11p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

14342 (AERE-M-2521) METHOD FOR DETERMINING THE DENSITY OF MILLIGRAMME SAMPLES OF FIBRES. Chidley, B. E. (Atomic Energy Research Establishment, Harwell (England)). Sep 1972. 9p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

14343 (AERE-R-7155) EXPERIMENTAL CAPACITANCE LIQUID FILM THICKNESS MONITOR. OPERATING INSTRUCTIONS AND CIRCUIT DETAILS. Benn, D. N. (Atomic Energy Research Establishment, Harwell (England)). Sep 1972. 33p. Dep. NTIS (U. S. Sales Only). UK 1.00 pounds.

14344 (ANCR-1040) FP8: FLOATING POINT ARITHMETIC SOFTWARE FOR DEC PDP-8 SERIES COMPUTERS. Myers, W. R. (Aerojet Nuclear Co., Idaho Falls, Idaho). Dec 1972. Contract AT(10-1)-1375. 51p. Dep. NTIS.

14345 (ANL-ES-19) EPISODE CONTROL STRATEGY FOR MOTOR VEHICLES. Rossin, A. D. (Argonne National Lab., Ill.). Oct 1972. Contract W-31-109-eng-38. 76p. Dep. NTIS.

14346 (BNL-17282) KINETIC OF GRANULOPOIESIS. Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). 1972. 29p. (CONF-720956-2). Dep. NTIS.
From Conference on radiosensitivity; Freiburg, Germany (25 Sep 1972).

14347 (BNL-17330) ABSOLUTE MEASUREMENT OF THE TRANSVERSE K-DEPENDENT SUSCEPTIBILITY IN ANTI-FERROMAGNETIC MnF_2. Lurie, N. A.; Shirane, G. (Brookhaven National Lab., Upton, N. Y.); Heller, P. (Brandeis Univ., Waltham, Mass.); Linz, A. (Massachusetts Inst. of Tech., Cambridge). 1972. 5p. (CONF-721114-14). Dep. NTIS.
From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

14348 (BNL-17336) SPIRAL STRUCTURE OF Ba_2CoReO_6. Khattak, C. P. (State Univ. of New York, Stony Brook. Brookhaven National Lab., Upton, N. Y.); Cox, D. E. (Brookhaven National Lab., Upton, N. Y.); Wang, F. F. Y. (State Univ. of New York, Stony Brook). 1972. 5p. (CONF-721114-13). Dep. NTIS.
From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

14349 (BNL-17345) USE OF PROTOPLASTS FOR GENETIC RESEARCH. Carlson, P. S. (Brookhaven National Lab., Upton, N. Y.). 1972. 25p. (CONF-721061-1). Dep. NTIS.
From Symposium on plant growth regulation; Washington, D. C. (16 Oct 1972).

14350 (BNL-17346) MAGNETIC PHASE TRANSITION IN $FeCl_3$. Endoh, Y.; Skalyo, J. Jr. (Brookhaven National Lab., Upton, N. Y.); Ooterhius, W. T.; Stampfel, J. P. (Carnegie-Mellon Univ., Pittsburgh, Pa.). 1972. 4p. (CONF-721114-2). Dep. NTIS.
From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

14351 (BNL-17495) INTRODUCTION TO THE BIOLOGY OF THE MAMMALIAN CELL. Elkind, M. M. (Medical Research Council, London (England). Experimental Radiopathology Research Unit). 1970. 18p. (CONF-721001-1). Dep. NTIS.
From Conference on physical mechanisms in radiation biology; Airlie, VA (11 Oct 1972).

14352 (BNWL-1519) EFFECT OF THERMAL SHOCK ON VULNERABILITY TO PREDATION IN JUVENILE SALMONIDS. II. A DOSE RESPONSE BY RAINBOW TROUT TO THREE SHOCK TEMPERATURES. Coutant, C. C. (Battelle Pacific Northwest Labs., Richland, Wash.). Nov 1972. Contract AT(45-1)-1830. 14p. Dep. NTIS.

14353 (BNWL-1692) MISSOURI RIVER HYDROLOGY (STREAMFLOW AND TEMPERATURE): SIOUX CITY, IOWA TO RULO, NEBRASKA. Schreiber, D. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1972. Contract AT-(45-1)-1830. 35p. Dep. NTIS.

14354 (CEA-CONF-2063) QUALITY CONTROL OF RADIO-PHARMACEUTICAL PRODUCTS USED IN RHEUMATOLOGY. Cohen, Y. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 6p. (In French). (CONF-710563-2). Dep. NTIS (U. S. Sales Only).
From Meeting on radioisotope synoviotherapy (synoviorthesis); Paris, France (26 May 1971).

14355 (CEA-R-3900) TURBULENT-DIFFUSION VERTICAL TRANSFER COEFFICIENT IN RELATIONSHIP TO THE ELECTRICAL PARAMETERS OF AIR. Milhau, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 51p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

14356 (CEA-R-4216) BEHAVIOR OF VOLATILE DROPLETS IN A CONTROLLED ATMOSPHERE. Perrault, Gerard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 194p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

14357 (CEA-R-4282) SHOCK TESTING USING ON ELECTRODYNAMIC SHAKER. Magne, M.; Leguay, P. (Commissariat a l'Energie Atomique (France). Centre d'Etudes Scientifiques et Techniques d'Aquitaine). Aug 1972. 58p. (In French). Dep. NTIS (U. S. Sales Only).

14358 (CEA-R-4325) AN APPROACH TO AUTOMATED CHROMOSOME ANALYSIS. Le Go, Roland (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1972. 374p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Paris Univ. (France). Faculte de Medecine.

14359 (CEA-R-4370) PROBLEMS RELATED TO THE AUTOMATIC PATCHING OF A HYBRID COMPUTER. Vergnes, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1972. 186p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Bordeaux Univ. (France).

14360 (CEA-R-4377) USE OF ANALOGUE DIGITAL INTEGRATORS IN GASEOUS PHASE CHROMATOGRAPHY. Schott, Roger (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Nov 1972. 36p. (In French). Dep. NTIS (U. S. Sales Only).

14361 (CONF-720208) EMBRYONIC AND FETAL ANTIGENS IN CANCER. VOLUME 2. Proceedings of the Second Conference, February 14-16, 1972, Oak Ridge National Laboratory. Anderson, N. G.; Coggin, J. H. Jr.; Cole, Elaine; Holleman, J. W. (eds.) (Oak Ridge National Lab., Tenn.). 1972. 379p. Dep. NTIS.

14362 (CONF-720623-3) COMPATIBILITY OF MICROBIAL MEASUREMENTS. Witkamp, Martin (Oak Ridge National Lab., Tenn.). 1972. 22p. Dep. NTIS.
From Symposium on modern methods in the study of microbial ecology; Uppsala, Sweden (19 Jun 1972).

14363 (CONF-721118-1) ENZYME ASSAYS IN ISOLATED AMNIOTIC CELLS. Moss, M. L.; Harris, W. W. (Oak Ridge National Lab., Tenn.). [nd]. 10p. Dep. NTIS.
From Symposium on recent developments in research methods and instrumentation; Bethesda, MD (30 Nov 1972).

14364 (COO-1247-26) TRANSPORT AND DEFECT PROPERTIES OF THIN METALLIC WIRES. Progress Report No. 9. Final Report. Bass, Jack (Michigan State Univ., East Lansing). 15 Sep 1972. Contract AT(11-1)-1247. 31p. Dep. NTIS.

14365 (COO-1332-76) POPULATION DYNAMICS OF RED FOXES IN NORTH CENTRAL UNITED STATES. Storm, G. L. (Minnesota Univ., Minneapolis). Dec 1972. Contract AT(11-1)-1332. 231p. Dep. NTIS.
Thesis.

14366 (COO-1469-212) AUTOMATIC SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS. Larsen, L. A. (Illinois Univ., Urbana. Dept. of Computer Science). Oct 1972. Contract AT(11-1)-1469. 129p. (UIUCDCS-R-72-546). Dep. NTIS.
Thesis.

14367 (COO-1574-31) PROPERTIES OF RARE-GAS SOLIDS. Progress Report. Pollack, G. L. (Michigan State Univ., East Lansing. Dept. of Physics). 1972. Contract AT(11-1)-1574. 12p. Dep. NTIS.

14368 (COO-1591-21) IMPURITY EFFECTS ON THE CREEP OF POLYCRYSTALLINE MAGNESIUM AND ALUMINUM OXIDES AT ELEVATED TEMPERATURES. Technical Progress Report, December 19, 1971-December 18, 1972. Gordon, R. S. (Utah Univ., Salt Lake City. Div. of Materials Science and Engineering). Dec 1972. Contract AT(11-1)-1591. 28p. (UTEC-MSE-72-197). Dep. NTIS.

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